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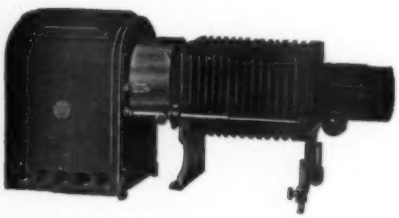

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SCHOOL SCIENCE AND MATHEMATICS

VOL. XX, NO. 9 DECEMBER, 1920 WHOLE NO. 173

UTILIZATION OF THE CHANCE PROJECT IN SCIENCE TEACHING.

BY FRANK B. WADE,

Shortridge High School, Indianapolis, Indiana.

As Prof. Rolland M. Stewart of Cornell University has so ably pointed out in his article on "The Project as a Method of Teaching," in the October number of this journal, the project method vitalizes instruction. Pupils who are really hot on the trail of a project that appeals to them are very different in their attitude, in their alertness and in their individual achievement from those who are merely attending school. This being the case, does it not behoove us teachers to attempt to use the project method of teaching to as great a degree as our command of the situation will permit? It will be the purpose of this brief paper to try to suggest, by means of an actual concrete experience in teaching, how one may go about making use of the project method. The experience will illustrate two types of project, the first type being that in which the project is suggested by the teacher, the second type is that in which the project has its origin in the desire of some member of the class to know the answer to some question of his own. The latter type of project is usually more successful than the former in arousing interest and stimulating effort on the part of the class.

In the particular case which we are to consider, the class was one in beginning chemistry. For six weeks, the class had been studying, largely by the laboratory method, the nature of oxidation. They had heated several common metals both in the air and under cover of melted borax. They had allowed iron to rust in a confined volume of air and had noticed the one-fifth loss of volume. They had weighed iron wire gauze, heated it, and weighed again, noting the gain in weight. They had burned

magnesium, and the teachers of each of seven different sections had oxidized accurately-weighed quantities of magnesium to constant weight and the pupils had seen the wonderful uniformity in the gain percent, as the data was all displayed on the classroom blackboard. By the use of a candle and lamp chimney containing sticks of caustic soda and counterpoised on a balance, the class had noted the gain in weight that attends combustion the products of the combustion having first been identified. Decaying leaf mold had been shown to be giving off carbondioxide. The class had also tested for carbondioxide in the breath and had noted the body temperature. Oxygen had been prepared from mercuric oxide and the history of its discovery had been sketched, including its early peparation by the Chinese from saltpeter, and Scheele's use of Saltpeter to prepare his "fire air."

The above brief outline will give some notion of what subject matter one might expect these pupils to make use of in attacking a project. The whole course, up to this point, had been built on the rather large project of discovering the true nature of tarnishing and rusting of metals, of burning, of decay, and of body combustion, in a word of common oxidation.

The experience which we are to attempt to describe, arose out of a written test or examination which was given at this time, to allow the pupils a chance to see how well they could make use of the knowledge they had acquired. The two principle questions were put in the guise of experiments, one performed before the waiting class by the instructor, the other performed by the members of the class individually. The examination virtually made use of the project method, but the project was advanced by the teacher.

A short candle was floated on a large cork on a dish of water and lighted. Several sticks of caustic soda were exhibited and named, then dissolved in the water in the dish. A large clean beaker was then inverted over the lighted candle and held until the candle had gone out and the sodium hydroxide solution had risen about on-fifth of the way up this beaker. The class was then told to record what had been seen, and to tell what they thought about it.

As it was not this question, but the other one, that led to the pupil project during the class discussion of the test the next day we will pass on with the brief comment that almost without exception, very complete observations resulted from the ex-

periment and many pupils were able to connect the results with the one-fifth loss of volume of air that they had met with during the rusting of iron. Most of them correctly interpreted the results, including the absorption of the carbondioxide by the caustic soda solution.

The second problem consisted in giving each pupil a piece of the mixture from a "Sparkler", a well known form of parlor firework. Magnets and lenses were available to each pupil. The pupils were told to examine the material carefully, then to hold it in crucible tongs and light it in a Bunsen flame. After that, they were to write what they had learned about it.

On going over the papers, it was found that nearly every one had detected the magnetic character of both the unburned material and the blue-black product of combustion, and had correctly assumed that the sparklers contained iron filings and yielded magnetic iron oxide. Many pupils also noted the presence of filings of a metal that was whiter than iron and most of them suspected, wrongly, that it was magnesium. (It was really aluminum.) Several suggested that there must be a binder present. The presence of an oxidizing agent, which we rather hoped some few might suspect, was not detected by any pupil. In this connection, it may be mentioned that their only opportunity to know of oxidizing compounds had been by hearsay, when the history of oxygen was sketched, and not by actual contact in the laboratory. Information gotten by the telling method evidently does not stick as well as that obtained at first hand. It is, of course, one of the virtues of the project method, that it supplies much first hand material.

On meeting the class the day after the test, the papers having been gone over in the meantime, the first of the two questions, that dealing with the candle, was discussed and every pupil given a chance to clearly understand to what extent he had succeeded in satisfying expectations and what more he might have done.

The question of the "sparkler" material was next taken up and the observations discussed and the conclusions weighed. When we came to the supposed magnesium filings, a boy, who had made, by the way, about as poor a record on the test as any member of the class, raised his hand and on being recognized, rose to say: "As I was going home last night, I saw them welding a rail with some stuff that had magnesium in it." Now when any member of a class rises with any such remark, there

is usually a project, and a real one, too, ready to one's hand, yet on this occasion, the teacher's reaction, at least within his own mind, was to the effect that the subject matter of the boy's project was contained in the very last chapter of the text under "Energy transformations in chemical reactions," and more specifically under "Aluminothermy." In other words, it was out of order at this time with a group of beginners. Fortunately, before the teacher's vocal organs had time to make the fateful announcement, his horsesense came to the rescue and he inquired further as to the character of the mixture used in welding the rails and the mode of using it. The boy was then sent at once to the stock room for some "Thermit" and a little of the mixture was given to every pupil in the class. Lenses and magnets were procured and the black brittle scales were identified as magnetic iron oxide. The bright bits of aluminum were recognized as being similar to those in the "sparkler" of the test. Although reserved for the last chapter of the text, the materials we had before us were precisely those we had just been discussing, either as original materials or as products. Instead of being *out of order*, the subject matter was *very much in order* and *every member of the class wanted to know about it.* Being asked how the men set their mixture on fire, the boy replied "with flashlight powder containing magnesium." He was at once sent for some powdered magnesium and allowed to try to light some, but could not light it either with a match or with burning paper. Neither could he light the "Thermit" in either of those ways.

A question from the instructor at once brought the suggestion from several members of the class that perhaps saltpeter would help by furnishing more oxygen. The review of the theme of oxidizing agents had had its effect. Saltpeter was at hand and the question arose as to how much to use. Right on the blackboard reposed the figures as to the gain in weight of magnesium on oxidation. Somebody saw them and offered the information that the magnesium needed about 66 per cent of its own weight of oxygen. Then arose the question, "How much oxygen can saltpeter give up?" Here the instructor had to help out by stating that it was very nearly one-half oxygen by weight. A balance, sensitive to .001 g., was procured, 100 mg. of magnesium were weighed out and twice 66 mg. of powdered saltpeter added and well mixed on paper. A large crucible was procured, on direction of the boy who had seen the welding

performed, the flashlight powder was tested and found to be very quick in its action and the remainder of it was mixed into the surface layer of the crucible full of "Thermit." A bit of magnesium ribbon was suggested as a fuse and a large pan of sand put under the crucible to protect the table top. The front seats were vacated and the fuse lighted. Beautiful fireworks! enormous heat! molten alumina and molten iron! slow-cooling, and then examination of the products. A brief recital of the great chemical attraction of aluminum for oxygen as compared with that of iron and the greater evolution of heat during its oxidation, and then advertising matter of the Metal and Thermit Corporation, which was at hand, was passed and the pictures therein contained taught some of the practical uses of the mixture. About this time the bell rang for the close of the double period.

Now one cannot expect to strike a gold mine like that, with every topic studied, but the thing to do is to be on the alert to use any such project that chances to turn up, even though the subject matter be contained solely in the last chapter of the book. Good judgment must, of course, be used to avoid going too far afield in such discussions. Here is where the project method will succeed or fail, according to whether it is used or misused. There must be skillful guidance, but when properly used, the results are fine. Let us all use it more largely.

SALT WATER AQUARIA FOR THE SCHOOL LABORATORY.

By Myrtle E. Johnson,

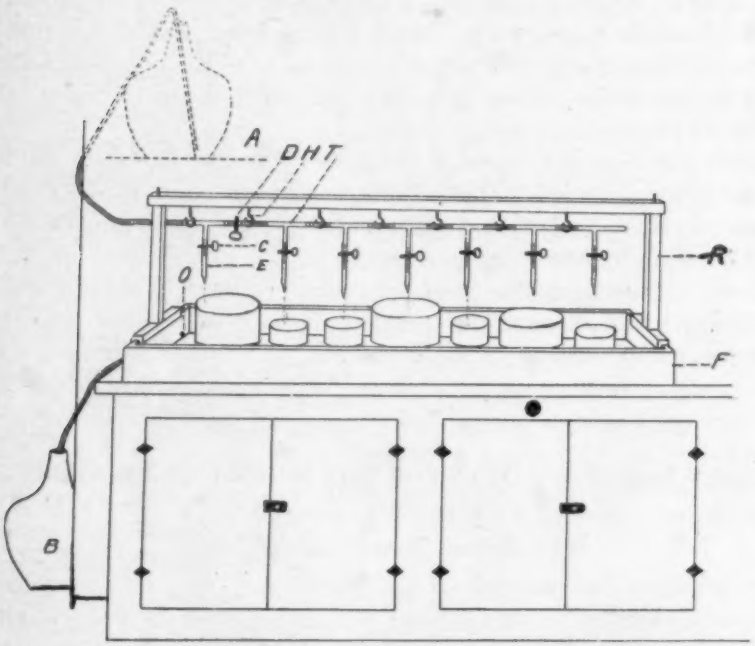
High School, Pasadena, California.

Although the contents of the "pickle jar" may be attractive to the seasoned zoology student, it is rarely so to the young high school pupils, while living animals if exhibited in an attractive way make a strong appeal. The device here described has been found useful for keeping marine animals alive and in good condition in the school laboratory.

In the large salt water aquaria where marine animals are successfully kept it will be noticed that care is taken to aerate the water constantly. Air is usually carried into the tanks along with the incoming stream of water. The apparatus described here is arranged on the same principle though it is so simple that it can be set up at very small cost of time and effort.

As shown in the diagram, the apparatus consists of a tray (F) for the aquarium dishes and a series of tubes (E) which

furnish a jet of water to each dish. The tray in this case is 6 feet by 1½ feet and 2 inches deep, of white pine, the joints snugly fitted, and the whole covered with three coats of enamel paint to make it water tight. The rack (R) for the tubing is made from 1x1 inch pine and has brass hooks (H) along the under side of the horizontal piece to hold the glass tubing. Glass T-tubes (T) joined by short pieces of rubber hose rest upon the hooks, a delivery tube (E) drawn out to a capillary point is attached to each T-tube, and spring clips (C and D) serve to cut off the stream of water when desired.



When we get specimens from the beach, we bring home several demijohns of clean sea water besides that which the specimens are in, for the latter is not of much use after the collections have traveled for several hours by automobile. The specimens are taken from the collecting cans as soon as possible and arranged in the dishes, which are filled with clean sea water, as few specimens as possible being put in one dish. A little eel grass and green algae are added to each dish when possible to help in the aeration and to give a pleasing color effect. A ten gallon demijohn of clean sea water is placed on the shelf (A) which in this case, is just inside a doorway in a closet and higher than the rest of the

apparatus. The water siphons down through the tubes and leaves the capillary nozzles with enough force to drive considerable air into the water in the dishes. The overflow from the dishes runs to the lower end of the tray and through the outlet (O) into the demijohn (B) which stands on the floor. To make the outlet we insert a three or four inch piece of glass tubing into a hole bored in the tray and pack the chinks with bits of cloth. The enamel paint fills up the remaining holes so that the joint is tight. Rubber tubing is attached to this glass tube. When demijohn (A) is empty, (B) is full, and they may be made to exchange places. If ten gallons of the sea water are run through the siphon two or three times a day it is usually sufficient to keep the creatures in good shape. Some kinds require more aeration than this, while some, such as the sea anemones, can get along with less.

By using a large sized atomizer bulb the siphon may be started with little trouble. Place a clip on the tube at (D), remove the glass tube (E) and the clip (C); attach the collapsed atomizer bulb to the tube at (C) and allow the bulb to expand. As soon as the water reaches (C), replace the clip there and remove clip (D), then remove the bulb and replace the tube (E).

If the animals that die and the food that remains uneaten are promptly removed from the water and if water that becomes cloudy is not allowed to mix with the rest, the aquaria remain attractive for some time. As the water evaporates, distilled water is added to keep the density uniform. The various parts of the apparatus are all detachable so that when it is not in use it is taken apart and stowed away in a small space. Corymorpha, clams, hydroids (*Clytia bakeri*, found growing on the clam *Donax*), shrimps, nudibranchs, crabs, small starfish and sea urchins, and other forms often difficult to keep alive have been kept for two weeks or more in these aquaria and sea anemones may be kept almost indefinitely.

A PORTABLE SCIENCE DEMONSTRATION DESK WITH A VERTICAL FILING SYSTEM FOR STORING APPARATUS.

By Chas. W. Finley and Earl R. Glenn,
The Lincoln School of Teachers College, Columbia University, New York.

General science has now become an established course in American high schools,[1] and in a recent report is recommended as a first-year course in those of Great Britain.[2] It frequently happens that because of the crowded conditions in schools this work is taught in rooms poorly fitted for science, in which there is inadequate demonstration materials or storage space for these materials. In many high schools it is the practice to spend most of the money allotted to science equipment on the courses in the upper years, with the result that there is a lack of materials

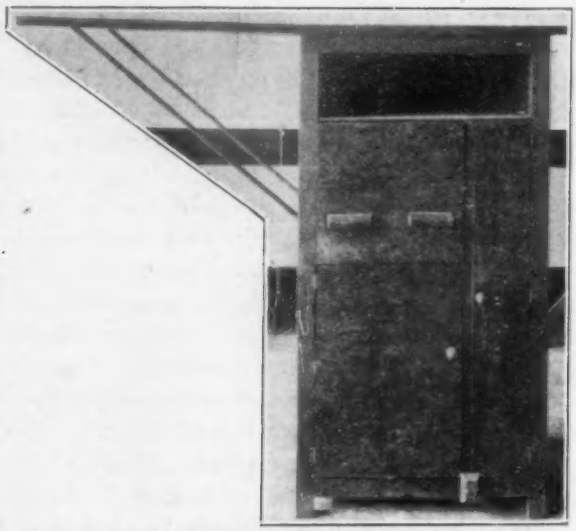


Fig. I.
Preliminary Model of Portable Demonstration Table.

and apparatus in the beginning science courses. When we consider that 150 first-year pupils out of each 316 do not reach the third year[3] it is evident that about half of the high school population is taught in classes inadequately equipped with science materials and apparatus. There seems to be a definite movement in general science teaching to make more use of demon-

[1]Report of N. E. A. Commission on Reorganization of Secondary School Science, 1920, U. S. Bureau of Education.
[2]Natural Science in Education. Report of the Committee on the Position of Natural Science in the Educational System of Great Britain, 1918.
[3]Bonner, H. R., Statistics of State School Systems, 1917-18. Bulletin, 1920, No. 11, Page 31.

strations. The knowledge that many teachers in general science have the work added to an already crowded day and that the teaching is often done in rooms poorly equipped for it, has prompted the writers to record a solution to the problem that has resulted in overcoming some of these difficulties and in the saving of much time.

Because of crowded conditions in our school it became imperative to teach a course in general science in a room devoid of gas and flowing water and in which there was no available storage space. For a few weeks it was the daily duty of one of the writers to return borrowed apparatus and materials and procure a new supply from a laboratory two stories removed from the room in which the general science was being taught.

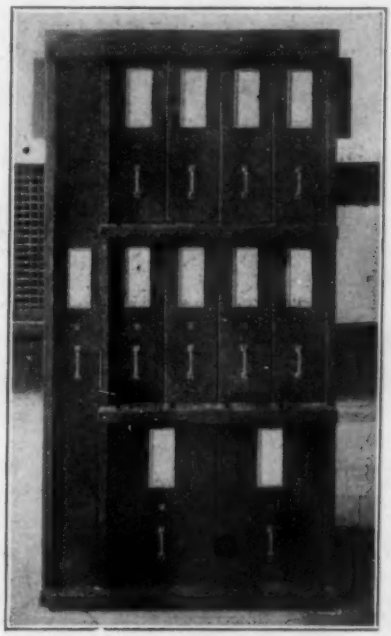


FIG. II.
SCIENCE DEMONSTRATION TABLE
AS SEEN FROM INSTRUCTOR'S SIDE.

This routine became a source of much wasted time and continual annoyance to both teachers concerned. It was decided to see whether some plan might not be devised to remedy this difficulty. A list of pieces of apparatus and of materials needed for the year's work was made out and the writers set to work to devise and construct a desk which would serve at the same time as a storage place for the apparatus and a demonstration desk for class use.

The first demonstration case was made by us in our own industrial arts shop. The joints were somewhat crude and it is very probable that the desk would not have been accepted as an addition to the furniture in that shop. It served our purpose, however, as in it we were able to store the apparatus and materials needed for the year's work. As is seen in the illustration (Fig. 1) it was equipped with a double top, so hinged that it could be opened, and braced against the side, making a space for demonstration work double the size of that of the regular top.

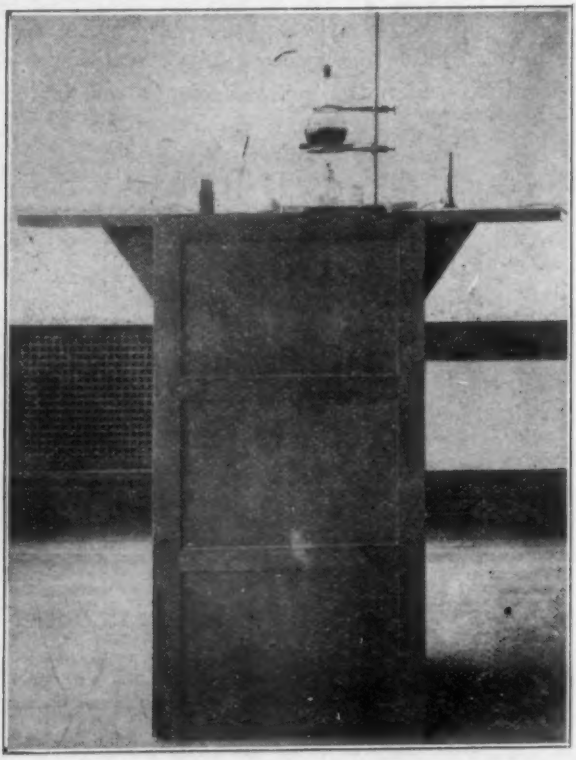


FIG. III.
DEMONSTRATION TABLE AS SEEN BY STUDENTS.

In storing the apparatus and materials needed for the work, all the available space in the desk was taken. This crowded condition made the case somewhat unwieldy and cumbersome. It will be noted that access to the space for storing the longer pieces of apparatus as yard sticks, meter sticks, glass and metal tubing was obtained through a door. It proved to be somewhat annoying to get anything from the back part of this narrow

space. So many small pieces were stored in the one drawer that constant effort was required to keep things in order.

A commercial company[4] has devised a vertical filing section which may be pulled the entire length from its case, making the entire contents easily available. The writers designed a desk patterned after the original one made by themselves but modified in such a way as to make use of the vertical filing system. In this new desk the contents of each section may be listed on the index plate as shown in figure two. We have found this index system easily applied to the appartaus lists given in the various science texts. By appending drawer numbers to the articles in the list one is able to save much time in locating apparatus for demonstrations (Fig. 3).

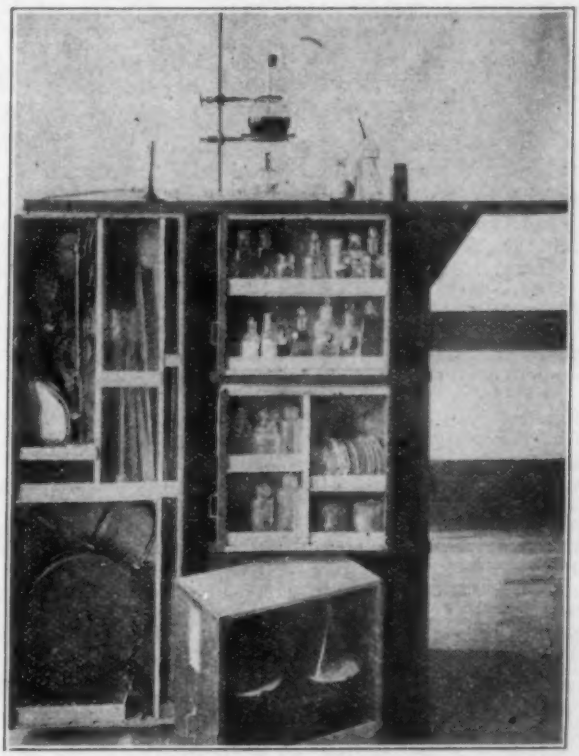


FIG. IV.
A CONVENIENT VERTICAL FILING SYSTEM FOR APPARATUS.

Figure four shows the contents of some of the sections. At the time this photograph was taken, two of the sections were

[4]Schwartz Sectional System, Indianapolis, Indiana.

empty and in the remainder there was stored the following articles:

Article	Quantity
A. GENERAL APPARATUS.	
Air pump	1
Alcohol lamp	1
Aquarium jar, small	1
Balloons, rubber	6
Bell jars	1
Bunsen burner	1
Burette clamps	4
Electric buzzers	2
Can, metal, one pint	1
Candles	3
Carbon rods	6
Clamps	6
Compass, magnetic	4
Copper, sheet, square foot	1
Copper wire No. 18, pound	1
Copper wire No. 24, pound	1
Cork borer set	1
Cork stoppers, assorted, dozen	1
Dry cells	5
Electric bells	2
Filter paper, sheets	500
Flower pots	12
Hammer	1
Hand lens	2
Electrolysis apparatus	1
Iron pans	12
Iron wire No. 20, pound	1
Locomotive model	1
Magnets, bar	4
Magnets, U-form	4
Matches, safety, boxes	5
Medicine dropper	1
Meter stick	2
Mercury, pounds	2
Microscope slides and covers	50
Motor, St. Louis form	1
Mortar and pestle	1
Needles, doz.	3
Osmometer	1
Pinchcock	6
Pliers	1
Pulleys, single	2
Pulleys, double	2
Push buttons	6
Ring stands	3
Rubber sheet, sq. ft.	1
Rubber bands, assorted, box	1
Rubber friction tape, roll	1

Article.	Quantity.
Rubber stoppers, assorted, lbs.	2
Rubber tubing, gum, ft.	10
Rubber tubing, heavy wall, ft.	10
Rulers	2
Scales, Cenco	1
Screw driver	1
Spring balances	2
Switches, battery	2
Test-tube brush	1
Test-tube holder	1
Test-tube stand	1
Thermometers	2
Tripod, iron	1
Tweezers	1
Weights, metric, set	1
Wire gauze	2
Y-tubes	2
B. GLASSWARE.	
Beakers, 100cc.	3
Beakers, 250cc.	3
Bottles, wide-mouth	12
Calcium chloride tubes	6
Cylinder, 1 liter	1
Dishes, crystallizing	3
Flasks, 500 cc.	2
Funnels	3
Glass tubing, assorted, lbs.	5
Glass plates	12
Graduates, 500cc.	1
Petri dishes	6
Test-tubes, assorted, doz.	4
Thistle tubes	2
C. CHEMICALS.	
Alcohol, denatured, pint	1
Ammonium hydroxid, lb.	1
Beeswax, oz.	8
Charcoal, lb.	1
Fehling's solutions, each, 4 oz.	1
Hydrochloric acid, lb.	1
Iodine solution, cc.	100
Iron filings, lb.	1
Lime water, oz.	8
Marble, lb.	1
Nitric acid, lb.	1
Paraffin, lb.	1
Potassium nitrate, oz.	8
Sodium hydroxide, lb.	1
Zinc, lb.	1

The firm mentioned above is now listing the case as a "Chemistry Desk." We are anxious however, to have it clearly understood that it was not designed as a chemistry desk, but as one for general science materials for use especially in schools or rooms not well equipped for that type of work, and that our only interest in the desk is the hope that it may be of help to other teachers of general science.

A CONVENIENT FORM OF THE NEW SINGING TUBE.

By Charles T. Knipp,

University of Illinois, Urbana, Ill.

The new singing tube recently described by the author[1] may be made to take an exceedingly simple and compact form. The tube need not be large, in fact, for this particular purpose, it works best where the various parts are of moderate dimensions, and when blown as a straight-form tube rather than a branch or L-form as originally designed.

Fig 2

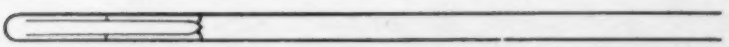


Fig 1

The form in question is shown half full size in Fig. 1. The outer tube is of heavy wall thickness, about 1 mm., while the inserted test tube is made out of the thinnest walled tubing that is procurable. The relative length of the inner tube is as shown in the figure. Its dimensions and the manner in which it is mounted within the outer tube are of the greatest importance. It has been found best to support the inner tube by three small glass projections symmetrically placed at its lower end. These are later fused to the outer tube as shown. To lessen the likelihood of the inner tube being broken from its rather frail support by rough handling three small additional projections are fused to the wall of the inner tube at its midpoint. These projections are ground off until the inner tube will just slip into the outer casing. The inner tube must also be perfectly centered. It is well to shrink the outer tube down onto these projections by returning the tube for a moment to the oxygen blast. This latter operation also affords an opportunity for exactly centering the open end of the test tube.

Finally, the outer tube is now closed as shown in Fig. 1. The successful operation of this singing tube depends upon the relative lengths of the inner and outer tubes; upon the annular area between the test tube and the outer casing; and, to a less extent, upon the wall thickness of the inner tube, and also upon the volume enclosed above the lip or open end of the inner tube.

By constructing a second tube, which is exactly similar to that shown in Fig. 1, except that it is a few centimeters shorter,

[1] A Possible Standard of Sound, Phys. Rev. N. S., XII, 6, p. 491, Dec. 1918; A Study of Energy of, Ibid XV, 2, p 156, Feb. 1920; I, Study of Operating Conditions, II, Study of Wave-Form, Ibid, XV, 3, p 244, Mar. 1920; Further Developments Relative to the New Singing Tube, Ibid, XV, 4, p 336, Apr. 1920.

and which is provided with a sliding extension (as shown in Fig. 2), the phenomenon of beats can be beautifully shown. The tips of the two singing tubes are heated simultaneously over a bunsen burner by holding the tubes one in each hand. By adjusting the extension the frequency of the beats may be changed at will. The two tubes are easily tuned. The tones emitted and the beats produced are readily audible over a large room. These tubes thus form a convenient companion set, and the phenomena that may be exhibited by them are both interesting and instructive. They are blown of pyrex glass.

THE EDUCATIONAL BASIS FOR JUNIOR AGRICULTURAL ORGANIZATIONS AND HOME PROJECT WORK.

By Jas. H. Greene,

University of Illinois, Urbana, Ill.

Man in general is interested in two things, *today* and *tomorrow*. *Yesterday* interests him but little in comparison with these two. As he grows older he sometimes becomes more interested in *yesterday* and *tomorrow* and less in *today*. But when he is of high school age while he makes the most of today, he likewise is thinking of *tomorrow*. What will it bring him of fame and fortune? Shall he cast his lot with the doctor or lawyer, the engineer or farmer?

Meanwhile the days are not long enough for the things he wants to do. All out-of-doors beckons him. The athletic teams, the growing plants and animals, books, his companions, his family, all present problems and activities of interest. He is living his life *today* and is loath to believe any who would tell him that this is merely preparation for *tomorrow*.

But he will listen to any proposition that seems to him to connect the two. That is one of the reasons that club work appeals to young people. The contact with livestock *their very own*, the responsibility for its care and management, the association with clubmates and leaders, the activities of clubs, hikes, excursions, exhibits and demonstrations, all of these activities appeal to them as being things of importance, *today*. But they are likewise of tremendous significance for *tomorrow*. These young people, who are now telling their stories of achievement in the club section of the Breeders' Gazette, will be the ones whose baby beef and hog feeding and breeding operations will be described in other sections of coming volumes of this paper.

Life—and life and education are practically synonymous

terms—is after all a matter of growth. The activity of today helps in successfully undertaking the slightly larger job of tomorrow. There is an old legend of a Roman general whose army had been defeated for the first time by an army of barbarians. The soldiers were discouraged and the old warrior wished to show them that final success is but the sum total of a number of small defeats and victories. He caused two horses to be brought out before the army. One was a magnificent animal, powerful in every line and muscle; the other was a mere bag of bones and was so weak that he could hardly stand. Then the general called out the most powerful man in the army, a magnificent fellow, over six feet in height and well muscled. He also produced a small, weak, mild-mannered little man, with no physique and unaccustomed to feats of strength.

He commanded the powerful soldier to pull out the hairs in the tail of the weak horse, *all at one time*. The soldier took a good grip on the tail and dragged the poor animal all over the ground, *but he could not pull out the hairs*. The little man was then ordered to pull out the hairs in the tail of the powerful horse, *one by one*. In a short time the tail was almost bare. It is recorded that the army took the lesson to heart and ultimately triumphed over the barbarians.

In clubwork young people tackle a real job of just the right degree of difficulty and after completing that, go on to one involving more thinking and more responsibility. A club enterprise is like a single hair in the tail, which we might call the big business of agriculture. The things necessary to make that enterprise a success are learned. Completing a series of projects or enterprises is like pulling out the hairs one by one.

Down in the little city of Effingham, Illinois, St. Anthony's Educationalists, who had been enthusiastic "clubbers" for a number of years, organized a "Thousand Dollar Tomato Club" last year. They secured a tract of about eight acres and carefully laid their plans. Heavy and prolonged rains delayed the setting out of plants and a luxuriant growth of weeds made another plowing necessary. Time was short and the plowing was done by a tractor, thus incurring further expense. Continued dry weather made cultivation difficult and delayed the maturing of the crop. Marketing time found a small crop matured but a high local price. The crop was already sold, however, to a canning factory at a lower price and the club members respected their agreement. Then came a strong local demand for green

tomatoes for pickles. Hope revived in the breasts of the young agriculturalists, but alas a sugar shortage prevented the club from realizing anything in this way. At the end of the season part of the "thousand dollars" was on the wrong side of the ledger and the club resorted to entertainments to pay for their "agricultural flyer." But the story is to be continued. This year the "Thousand Dollar Tomato Club" is again at work and has added a small commercial canning outfit to its equipment. When the time comes to harvest the crop, the club expects to be independent of immediate market conditions. It has capitalized its difficulties and is "pulling out the hairs one by one." Though its receipts may not reach the thousand dollar mark this year, the club eventually will attain its goal and ultimately win it. It matters not what calling in life is ultimately followed; whether medicine, law, engineering or business, somewhere that occupation will touch agriculture, and the first-hand information which is acquired in running a farming enterprise will prove of service.

The boy or man who prefers to lead a hermit's life is an exception. The success of athletic teams, debating societies, class or school parties, and picnics depends upon organized effort. One likes to share his pleasures and his responsibilities with his friends. Riley gives a picture of this in his poem, "The Impetuous Resolve:"

When little Dickie Swope's a man,
He's go' to be a sailor;
An' little Hamey Tincher, he's
A-go' to be a tailor:
Bud Mitchell, he's a-go' to be
A stylish carriage-maker;
An' when *I* grow a grea' big man,
I'm go' to be a baker!

An' Dick'll buy his sailor-suit
O'Hame; and Hame'll take it
An' buy as fine a double-rigg
As ever Bud can make it;
An' nen all three'll drive roun' fer me,
An' we'll drive off togevver,
A slingin' pie-crust 'long the road
Ferever an' ferever!

The organization side of club work is of great future importance. Everywhere, organizations are springing up. Do

we have a grievance? Organize all others with similar grievances and secure our rights. Unfortunately, many organizations are being wrecked on the rocks of greed and selfishness and all because there are only a few men in these organizations who know how to conduct business. These leaders are playing upon the ignorance of the mass of the membership and leading them astray. We cannot afford to belong to an organization and lend our support to it unless we understand the machinery and know how to keep it headed straight. The farmer, it can be said, has seldom, if ever, lost his head in his organized demands upon society. In many cases, he has held a brief for society in general as against a particular group of middlemen. For this reason, it is all the more important that he should know how to work in an organization.

There are two other important things to be considered in connection with organizations. First, successful leaders in any organization must know how to meet men and deal with them. This training can be acquired only through experience, although of course, some individuals have more native ability along this line than others. Second, no organization can long succeed which does not take into account its responsibilities to other individuals. A sheep club or pig club, which planned deliberately to make use of its organization to market its stock dishonestly, would not long succeed even if it could "put over" the first "crooked deal."

If education is "growth" and is not "preparation for life" but *life itself*, as one educator has expressed it, the materials of education should be those life situations which will develop habits, skill, appreciation and ideals of the right sort. Necessarily the size and scope of these life situations must be reduced to fit the mental and physical stature of young people. When these life situations are those that are a part of the normal interests of healthy, wholesome individuals it no longer becomes a problem for the teacher to get these young people to enter whole-heartedly into the activities in question.

Club organizations and home projects provide such life situations. Club leaders and vocational agricultural teachers have the responsibility of guiding these activities of *today* in such a way that they will enlist the whole-hearted participation of these young people and will build for *tomorrow*.

THE DECAY OF MOUNTAINS AND THE FORMATION OF SOILS

By Lyman C. Wooster
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1. Soils.

Soils are indispensable to all forms of life, for without them land plants could not exist on the face of the earth and without land vegetation all forms of land life must live on the products of the rivers, lakes and ocean or must perish, since all animals feed directly or indirectly on plants.

As soils are products, chiefly, of rock decay, the two problems are closely linked together and must be solved as one. Study of soils should come first as the special phases of rock decay to be studied in this paper are determined by soil composition.

The chief physical components of the soil are as follows:

Bowlders, 3 feet to 3 inches.
Gravel, 3 inches to 1-25th of an inch.
Sand, 1-25th of an inch to 1-500th of an inch.
Silt, 1-500th of an inch to 1-5,000th of an inch.
Clay, 1-5,000th of an inch to 1-250,000th of an inch.
Humus, of varying size.

All these components are found in most soils but in varying proportions, so the name is determined by the dominant component. These soils or loams with their characteristic crop or crops are:

Stony loam—forests.
Gravelly loam—berry bushes.
Sandy loam—potatoes and melons.
Silt loam—alfalfa and corn.
Clay loam—wheat and pasturage.
Humus loam—rice and cranberries.

These soil components are valueless for crops when alone, but serve each to supplement the others when combined so as to meet the needs of the plants.

Held in the interspaces of these loams are various substances, held in solution by water, that are necessary to green plants in food-making. These substances may be placed in two groups, as follows:

Food materials and elements.
  Water—H and O
  Carbon dioxide—C
  The saltpeters—N
  Gypsum—S
  Fosfate rock—P
Accessory food materials.
  Soluble compounds of potassium
  Soluble compounds of iron
  Soluble compound of calcium
  Common salt
  Silica

How these accessory food materials are used by the plants

is not known, but the biologist has determined that green plants cannot make sugar unless potassium is present, nor chlorophyl unless iron is present, yet neither metal is found in these products.

These food materials are present in sufficient quantities in the loams for the various crops unless the balance has been destroyed by unwise farming. In the latter case they must be returned or the yield per acre will certainly be diminished. Some of these materials are yielded, with the soil components, in the decay of mountains or of the sedimentary rocks of the plains, part through the decay of plants and animals or from the excreta of the latter and part from the atmosphere. Knowing these sources of these food materials the farmer must use his power to determine which is lacking and supply it.

Taking next the decay of rocks we shall find that the problem must be divided into two parts, the second depending for its solution on a right understanding of the first part.

2. Rock Decay in Mountains.

"As durable as the everlasting hills" is not accepted by the geologist as meaning a great duration, for of all regions of the earth the mountains are most subject to change, and are most quickly removed through erosion and carried to the sea.

The common rocks of mountain ranges are granite, gneiss, mica schist and hornblende schist. The minerals composing these rocks are quartz, feldspar, mica, and hornblende. Of these minerals feldspar is most abundant and is quickest to decay. With feldspar gone the quartz is rolled down the mountain slopes by gravity, rains and rivers to the sea-shore where it is reduced to sand by the waves. The mica, small in amount, generally goes with the sand. The hornblende decays with the feldspar.

As one climbs up and down the mountain ridges about Estes Park, Colorado, he ceases to wonder how the glaciers of North America managed to pick up and push to the lowlands the millions of tons of boulders and finer material which cover the surface of the United States from Cape Cod to Puget Sound. The massive moraines of Estes Park could be duplicated several times over should glaciers again clean the neighboring peaks and ridges of the Park of loose rock material.

Geologists name the outer eight or ten miles of the earth the zone of fracture because the rocks in this zone break when flexed or folded; and the deeper parts of the earth, the zone of flowage, because the rocks here are so hot and are under such

great pressure that they flow under local stresses as in mountan making.

Geologists say further that the interior of the earth is shrinking from loss of energy and that the surface zone, in accommodating itself to a smaller interior, is forced into anticlines and synclines by lateral pressure. These wrinkles in the face of mother earth are the mountains with their peaks and ridges carved from the great ridges. But flexures of the rock in the zone of fracture must result in its being deeply fissured, thus exposing the rocks of this zone to the solvent action of water, the rending of frost and the weathering action of the atmosphere.

The most vulnerable minerals in rock decay are the feldspars and hornblende, and the chief agents in mineral decomposition are water, carbonic acid and silicic acid. Common feldspar, the feldspar of the granites, gniesses and schists, is a double silicate of aluminum and potassium. The carbonic acid of rain-water removes the potassium, combines with it and makes potassium carbonate, one of the ingredients of the alkali of clay soils. On meeting nitric acid the potassium carbonate becomes potassium nitrate or saltpeter, one of the necessary food materials. The remainder of the feldspar is kaolin, the chief ingredient of clay, and colloidal silicic acid. As all know, clay is the chief component of most soils between and near mountain ranges, carried there by the rains and rivers.

More than one-half of the thickness of the strata penetrated by deep wells in Kansas is clay rock or shale. The clay of this shale came from the Ozarks of Missouri, the Arbuckle and Wichita mountains of Oklahoma and from the Rocky Mountains of Colorado.

The colloidal silicic acid, released when the carbonic acid combined with the potassium of feldspar, is part of it carried into the rivers, lakes and ocean where it yields silica to the various plants and animals that use this substance for their skeletons, notably diatoms, rhizopods and sponges. The remainder of the acid descends with the water to the zone of cementation and either converts the sandstone into quartzites or descends still further to the deeper, hotter parts of the zone and changes the carbonates into silicates. The carbonic acid released then ascends to the zone of weathering and sets free more silicic acid which then descends to the zone of cementation, doing work as before.

In a similar way the soda-lime or plagioclase feldspars of the lavas and other extrusive materials are decomposed in the zone

of weathering by carbonic acid with the production of sodium carbonate and calcium bicarbonate and kaolin and the liberation of silicic acid. The sodium carbonate may be changed to common salt on encountering chlorine or to Chili saltpeter on meeting nitric acid or it may be laid down with the kaolin in beds of clay and be black alkali so destructive to crops. The calcium bicarbonate is the "lime" of hard water. When freed of half its carbonic acid it serves as excellent material for the skeletons of water plants and animals.

The intrusive basic rocks such as gabbros and diorites also contain the plagioclase feldspars. These consist of silicic acid combined with aluminum, sodium and calcium and meet the fate described in the preceding paragraph. Associated with the plagioclase feldspars in these basic extrusives and intrusives are augite, hornblende and various compounds of iron. Carbonic acid reduces all these minerals in the zone of weathering to carbonates and simpler silicates, such as kaolin.

Summary: The minerals composing the granites, gabros and lavas are reduced in the zone of weathering to kaolin, potassium carbonate, sodium carbonate, calcium bi-carbonate, magnesium bi-carbonate and iron bi-carbonate. In time, or more rapidly under the influence of heat, carbon dioxide leaves the iron bi-carbonate and the latter becomes the red or brown oxide of iron so evident in brick and in red sandstone.

Brought up from the zone of cementation where silicic acid is supreme by the mountain-making forces to the zone of weathering where carbonic acid rules, the granites, gabbros and diorites and basic lavas slowly yield part of their basic metals to carbonic acid with the result that the mountains are brought low and the tributary rivers are loaded with sediments for transportation to lake basin or continental margin.

Not all the results of weathering reach the lake basins or the marginal continental shelf at once but much of it lingers on the way to serve as soil and subsoil for the use of vegetation.

3. THE DECAY OF FRAGMENTAL SEDIMENTARY ROCKS.

The boulders, gravel, sand, silt and clay that reach some interior lake or sea or the continental shelf on the borders of the ocean become cemented and compacted in the course of millenniums and are then termed by the geologist conglomerates, sandstones and shales. In a silimiar way the coral reefs and shell beds are beaten and ground by the waves of the sea till fine or coarse grained limestone results.

Then the sea-bed and the continental shelf are lifted above the sea level by the slow and long continued elevation of the earth's crust by the same forces that caused the ranges of mountains to come up along the borders of the sea, and we have the great plains and plateaus between the mountain ranges of our continents.

As in the case of mountains the water, frost and carbonic acid attack this new-made land converting the sandstones, shales and limestones into loams for the use of vegetation.

The clay of shale furnishes its own cement. The cements of sandstone are clay, calcite (calcium carbonate), ferric ozide and silica. Rainwater slowly changes the shale back into clay, rainwater and carbonic acid remove the cements of sandstones, excepting silica, and the sandy loams good for potatoes and watermelons show the nature of the underlying rock. Rainwater and carbonic acid may remove all the calcite of limestone leaving merely impurities such as clay, or they may take away first the cement leaving for a time the fragments of corals and shells for the geologist to carry away for his collections.

The cement becomes calcium bicarbonate and flows with the water to the sea. In the sea the corals reject half of the carbonic acid and use the calcium carbonate for their skeletons. In the course of time the skeletons are reduced by the waves to limestone mud and this soon becomes limestone, completing the cycle when the sea becomes dry land.

This accounts for the sandy, silt and clay loams through the weathering of sandstone, shale and limestone by the action of rainwater and carbonic acid. But what is the origin of the stony, gravelly and humus loams?

It is now known that a broad ice sheet shoved southward from Canada as far as the Missouri and Ohio rivers, Northern Pennsylvania and New Jersey and Long Island bringing enormous quantities of pulverized limestone, sandstone and shale and billions of tons of boulders and gravel composed of all kinds of rock over which the ice sheet passed and left the load spread out where the ice melted.

Elsewhere in Eastern Kansas the gravel is derived from the chert (flint) concretions of the decaying limestones. Humus loam receives its organic matter chiefly from the decay of the leaves and roots of plants that have grown in the soil where the humus is found. This is a fortunate distribution of humus for no soil is fertile without humus and the included bacteria.

FIELD TRIPS—NOTES ON MANAGING.

By Ellis C. Persing,
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The topic for consideration is not one of my own choosing but one which I am glad to discuss because I believe that it is one of the vital problems in the teaching of science, especially in the teaching of biological science.

Since the relation of recitation, laboratory, and field is so close, a discussion of one includes a consideration of the other two. Much criticism has been directed against science teaching because of bad methods and inefficiency in field and laboratory work.

The natural laboratory is the great out-of-doors, but since conditions will not always permit us to do the work in the field, it must be done in the schoolroom. Sometimes, however, it is an advantage to do the work indoors with the necessary equipment and protected from the weather. I have known teachers who consider field work as something separate and apart from the regular work of the course. The result is that pupils soon acquire the same idea and look upon a field trip as a picnic and go for no other reason than to have a good time. On the other hand, pupils may acquire a feeling of dread for field work because the work is not motivated and unnecessary notes are required.

The latest data[1] available indicates an increased interest in field work on the part of the teachers with an encouraging increase in the number of schools offering this phase of the work in connection with biological science.

The content and nature of the course will affect the field work. Courses in biology and botany are rapidly being reorganized to suit the needs and follow the interests of the pupils rather than to present the subject in a logical way. Morphology, which was so much emphasized a few years ago, is being replaced by phases of the biological subjects which make applications to the life of the pupil and the community.

To be of value in proportion to the time spent, I am convinced that a trip must have a definite purpose. I can not agree with those who believe that the class should go to study plants and animals as they may happen to come to their attention. The purpose may be stated in the form of a problem or a number of problems. These problems may have been suggested by the

[1]Downing, Elliot R., "Some Data Regarding the Teaching of Zoology in Secondary Schools." School Science and Mathematics, Vol. XV, pp. 36-43.

pupils and teacher in the class discussions previous to the trip and will then be attacked with interest by the pupils. This lack of motivation is easily noticed in the field or laboratory work, which becomes mere drudgery on the part of the pupil and gives a feeling of relief to the pupils when the period has closed.

If possible, the teacher should go over the field before the trip is made with the class. This will avoid needless confusion and with the wise teacher will aid in suggesting problems which can be studied on the trip.

It has been my experience that unless pupils are required to record their observation by means of drawings or words, they are liable not to see with exactness. This does not mean that pupils must make artistic drawings, as crude sketches many times may indicate the facts in a scientific manner.

A great deal of time may, however, be wasted by requiring pupils to spend one-half or more of the field or laboratory period in writing unnecessary directions, which means that very little time will be available for the study of the real problems.

The specimen sheet for a field trip has been used by the writer for a number of years. It is only suggestive for the pupil and should not be handed to him before the discussion has led up to these problems or similar ones. Without the proper motivation and the personality of the teacher it would be useless.

FIELD TRIP.

No..... Name.....

Time..... Place.....

.....

Problem.

1. To identify some of the common weeds.
2. To make a weed survey of some vacant lot or the roadside.
3. To collect material to be used later in the work.

Directions and Observations.

1. (a) Take some weed manual with you on the trip and use to help you in finding the name of the weed.
   (b) Record the names of the weeds identified on the back of this sheet.
2. (a) Determine the number of different kinds of weeds on the lot agreed upon for that purpose and record.
   (b) Calculate the number of weeds per square foot on the lot and record.
3. Collect any material that may be of use to the class later in the work such as *fruits*, *seeds*, *leaves*, etc.
4. Have a good time but do not forget that we have some work to do.
5. When you return from the trip carefully sort all materials collected, label and set aside in some place assigned to you for that purpose.

Inference.

1. What structures and characteristics enabled you to identify the weeds?
2. How does the number of kinds and the number per square foot compare with what you expected to find?

Remarks.

Record any questions which were not fully answered in the field, and any other question for class discussion.

A laboratory manual should be used in somewhat the same way in which a catalogue or guide would be used in visiting one of the large museums. The museum catalogue directs our study, leads us to make certain observations and supplies facts necessary for us to make our own generalizations. If used in this way a sheet of printed directions or a manual will be a great help to the pupils. The teacher can then work with the smaller group or individuals as the occasion may require and at the same time the other pupils will have a guide by which they can go on with the work until the teacher may find time to help them.

Field or laboratory work may consist of individual projects instead of group work. The pupil may be interested in some phase of biological science as collecting to complete the life history of some insect, growing a home garden, collecting material for the aquarium or working on some other problem of special local interest. The teacher, of course, should make suggestions and help as the occasion may demand. A certain amount of credit is given for this work, consistent with the system of grading.

As a means of accomplishing the laboratory and field work, a growing room or greenhouse is necessary, with a small plot of ground on the school lot, where plants can be kept for experimental purposes. Animals should be studied in the field whenever possible, but much time may be saved by keeping some animals, such as insects, in the laboratory under as nearly normal conditions as possible where observations may be made daily. Local conditions determine just what equipment is necessary; but the expence for this scheme is not great. In laboratories which do not already have growing rooms, changes necessary to make such rooms could easily be made. The breeding cages and aquaria can be made at a small cost with the help of pupils who are usually glad to aid in such work.

In the city a number of difficulties at once arise. One is to find a suitable place for the trip. It is not always possible to find an ideal place for this work but in many cases a trip can be made to a nearby vacant lot or to a city park. It is by no means

necessary to make a trip of ten or fifteen miles to the country when much available material may be found near to the school.

A trip to some large greenhouse may be taken to give an opportunity to study a number of problems relating to plants such as plant culture, how plants can be used in and about the home and to gather data for many other problems.

Another kind of trip, and one which I consider of as much importance as any that is taken during the year, is the one made to the laboratories of the City Health Department. Pupils make this trip about the time the topic of bacteria and disease is studied. This adds interest to the class work and shows the practical application of the subject to human welfare.

When two periods are not available in the regular schedule for this work, arrangements can sometimes be made with the principal for the pupils to take a half day once a semester for such work. A half day is necessary when a long trip is taken. The time required to travel the long distance to country or field warrants more than forty-five minutes to one hour in the field for actual work. In some cases the trip can be made after school or on Saturday, according to the nature of the trip and the arrangement of the schedule.

It is an advantage to organize the classes into a Science Club. The pupils then take an active part in planning the trips and working on certain projects, such as making collections of various kinds for exhibition or classroom use, or taking a bird census.

With the reorganization of education during war times we are led to consider our courses of study with a view to eliminating non-essentials. If field work is essential, and I firmly believe it is, then let us make it of such a nature that it commands the respect of pupils and administrative officers. It is our duty as teachers to pause long enough to consider our methods, whether they are the means by which we can accomplish the best results and, if not, to revise them at once.

With definite problems, proper motivation and work carefully planned, the field trip and laboratory work should cause little trouble for the teacher and be a great help to the pupils.

THE APPLICATION OF ENGINEERING AND SCIENCE IN SHIPBUILDING.

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As this paper is to be a discussion of various phases of ship construction, it might be well to begin with the derivation of the word "ship." Translated literally from the Greek it means a scoop. The most probable inference that can be drawn from this is that the boat or ship that was known to the earlier Greek writers had the form of a hollowed out log. In literature mention is made of ships by Homer and Virgil as well as by earlier writers. The word that we use today being of Greek origin depicted the boat of the period though conclusive evidence exists that the water borne craft had large use long before this time. The development of the ship is the result of constant improvements which can be divided into seven stages.

1. Rafts or bundles of brush or reeds that gave sufficient buoyancy
2. Dugouts or logs that had been hollowed out either by the use of fire or crude tools.
3. Canoes composed of bark or skins sewed together.
4. Canoes built of pieces of wood or reeds firmly fastened or woven together.
5. Vessels constructed of wooden planks with members that acted as stiffeners also with at least partial decks.
6. Vessels constructed with a complete framework which largely took up all the stresses, the wooden covering on the hull being simply designed to act as a shell to keep the water out.
7. Vessels composed of steel.

Well authenticated descriptions exist of some of the earlier types. Probably the first advance from a simple raft was the addition of a raised platform on which the passengers or cargo being transported could be placed and keep dry. In the light of present day construction this expedient seems very crude but was a marked advance at that time. Similarly sides were raised on rafts used in warfare, first as a protection from the missiles of the enemy. This was the predecessor of the portion of the ship now known as the gunwale, and for each and every portion of a modern ship such a historical tracing could be drawn. That development has occurred concurrently along almost similar lines in different portions of the world is well known. In some cases this has occurred entirely independently, giving a wonderful illustration to the fact that most of the benefits of any civilization are simply the answers to desires, and are possible of realization only by the application of scientific principles. That this application may be made without a thorough

understanding of laws at work is not only conceivable but is demonstrated all around us. The chief difference between the primitive shipbuilder and the one of the present time is that the primitive man followed scientific principles much in the same manner as a child learns to keep away from a fire for fear of getting burnt, while the one of today searches for the underlying laws and then guides his work in accordance with them. This in fact, gives us a good definition of pure engineering which in a few words is the prosecution of constructive work by the aid of and in complete accord with the laws of nature.

The small boat with an outrigger to assist in maintaining its equilibrium is still found in the Islands of the South Sea and seems to be typical of development in these parts. The legends of the Phoenicians and the Egyptians bear evidence that mariners from both of these countries had visited portions of the South Seas and the absence of boats equipped with outriggers in the case of both Egypt and Phoenicia would seem to indicate that they had developed at the time of these visits superior boat types of their own.

The earliest Egyptian records that describe boats are given a date of about 3000 B. C. and the boats there described must have been of some size as they were powered by many rowers. When the ultimate power that could be produced by one set of rowers had been obtained types were developed using two and three banks of oars. These are known as biremes and triremes. Where credit should be placed for the development of biremes and triremes is uncertain except that it lies between the Egyptians and the Phoenicians. It is known, however, that the art of navigation was greatly advanced by the Phoenicians though unfortunately information regarding that progress has come to us through Assyrian sources. The Greeks developed a large undecked galley type which was stiffened with hogging cables running full length and supported over check timbers amidship.

Up to the time of Christ the chief forces behind ship construction had been military ambition and conquest. Despite this, some nations such as Phoenicia were principally traders. Early in the Christian Era the pirates who had infested the Mediterranean Sea were largely subdued and much commerce resulted. During this period all types of sails and rigging showed marked improvement. In passing it might be well to mention several other periods that have been particularly active in maritime

history. While it is true that the inhabitants of the Scandinavian peninsula have always been sea-faring people and have done much along these lines they have not been a very large factor during the last few centuries. The early Norse seamen are believed to have visited America in the Northern latitudes many years prior to its discovery by Columbus and are known to have visited Iceland and other portions of the Arctic Regions.

About the close of the twelfth century the Crusaders started for Palestine and as a result there was a big boom in shipping, particularly in England. From this time up to the discovery of America much interest was taken in water trading. After the discovery of America three countries became very keen if not altogether bitter competitors in trade namely Holland, Spain and England. In the sixteenth century Spain who was then in her zenith of power decided to build a large battle fleet and to subdue England as well as all her other trade competitors. Therefore in 1588 the great Spanish Armada set sail for the North to make Spain the complete mistress of the sea. It numbered all told 132 vessels the largest of which was of 1300 tons burden while 30 were under 100 tons each. They were most ingloriously defeated with the aid of the elements and this battle led to England becoming the mistress of the sea, which position she has held without much opposition except the competition of America in the time of the Clipper ships and today and Germany. The shipbuilding activities of the United States during the war greatly increased our tonnage at a time when England was having difficulty holding her own.

In 1777 an item appeared in the London Gazette announcing the launching of an all iron boat on the River Foss, Yorkshire, England. Shortly after this the substitution of iron for wood became quite general for portions of the ship. As is true in any departure from current practice much adverse criticism was brought forth and the contentions of the critics can be summarized under four heads.

1. The weight of iron being so far in excess of that of wood would make it impracticable of use. The fallacy in this statement is readily discernible by everyone today though for a long time it held considerable weight. If the above contentions were true, we would find the largest ships constructed of wood rather than of steel which is the only practical material in present use.

2. In the event of grounding or collision that an iron ship would stand less abuse than one constructed of wood. Experi-

ence has shown that this is not the case. Steel is the more resilient material and as a result will stand sudden shocks with greater freedom from danger than wood under the same conditions.

3. That an iron ship would corrode and foul more rapidly than would the wooden one. This argument had really more weight than the two preceding ones, but steel ships today are kept in shape with little if any more trouble than the wooden ones.

4. Owing to the magnetic properties of iron the action of the compass would be interfered with, rendering navigation by its use impossible. In 1839 Sir G. B. Airy read before the London Society a paper in which he described some experiments and made suggestions as to methods by which these troubles could be overcome. The methods now in use are simply modifications of the suggestions which he made at that time.

Steel ship construction as we know it today was first introduced about 1870. The improved methods used in this type of construction will be described later on.

The mechanical or power side of ship construction has shown, similarly, wonderful development along with that of hull construction. There are three types of energy that have been applied to ship propulsion. These are manual, sail, and mechanical. The manual will include poling, paddling, and rowing. The sail appeared in very early examples, in the first cases being in the nature of an auxiliary to rowers. The highest example of a sailing ship is found in the Yankee Clipper Ship that is said to have shown his heels to all the world.

Even while the Clipper Ship was at its height, steam propulsion was making its appearance. All the earliest installations were of the single cylinder type. In 1854 John Elder successfully used a compound engine on a boiler pressure of 42 pounds. After several trials which had proved disappointing largely on account of the low steam pressure employed, Dr. A. C. Kirk introduced in 1862 a triple expansion three crank marine engine.

For this installation he had raised the boiler pressure to 125 pounds marking the beginning of the movement toward high pressure boilers and in a special craft we now find pressures of 300 pounds and upward. Another development in power machinery was the introduction of the steam turbine. Many advantages are claimed for it over the reciprocating engine but there are several disadvantages that apply particularly to marine installations. The very latest development in power units is what is known as the electrical ship. In this type the turbines

are connected with generators and have no direct connection with the propeller shafts. Each propeller shaft is connected to driving motors which are run on the electricity generated by the turbo-generators. In these vessels the shafts do not have to run through to the engine room as the motors may be placed as far aft as there is clearance. This type of construction has been developed and adopted by the United States Navy for all its new construction of Capital Ships.

We have given a brief description of the development of marine power units. Before leaving the subject of propulsion it might be well to describe the various contrivances that have been developed to apply the power of these several units. The earliest steam boats were all driven by paddle wheels. Even now boats designed for service in shallow water, such as many rivers, are fitted with paddle wheels. Some of these installations are on the side while others have the paddle wheel on the stern.

We now come to the screw propeller. Many interesting experiments were made by Colonel John Stevens of the U. S. Army on screw propellers but the first commercially successful one was developed by Capt. John Erricson. He took out his patents in 1836. Much improvement has been made since that time on the screw propeller and well designed propellers are now in use in all kinds of service. There is hardly a portion of a modern ship or its equipment that has received more attention along strictly scientific lines than has the screw propeller.

Since a large portion of all ships now built are constructed of steel the remarks that follow are to be considered as relating to vessels constructed of that material especially. Steel ships are now constructed under one of two systems of framing. These are known as the transverse frame and the longitudinal frame or Isherwood systems. In the first the stiffening members or side frames run in the direction of the width while in the other as its name implies they run in the direction of the length of the boat.

By far the greatest number of vessels are still built of the transverse type though most tankers are now built on the Isherwood System. A boat consists first of the outside steel shell or plating, the plates of which are riveted at the ends and sides. The shell in the transverse type is carried or stiffened by channel side frames. In a typical section of the central portion of the ship the side frames extend from the bilge or turn of bottom into the side of the vessel up to the highest deck

to which the shell plating is carried. At the bilge the side frame is attached to a piece of plate called the bilge bracket. These bilge brackets carry an angle clip to the shell which has a curved outline and another clip to the tank margin or plating that forms the limit of the double bottom. The double bottom is the space between the outer bottom shell and another set of plating inside the ship which is generally parallel to the bottom shell and about three feet from it. In the cargo vessels of 8,800 DW Ton type this inner bottom or tank top was carried to within about six feet from the sides of the ship and from here was turned down so as to meet the bottom shell just at the turn of the bilge. It is this portion of the inner bottom that turns down which is known as the tank margin and to which the bilge brackets just described are attached. The double bottom is braced first by the centre vertical keel which is a continuous plate girder running full length. At each frame a floor or transverse girder is placed and is firmly connected at bottom with the shell, at the top with the tank top, at the inboard end with the centre vertical keel and at the outboard end with the tank margin. The vertical keel is watertight and floors at stated intervals are also watertight. This construction gives a series of tanks each independent of one another. All floors not specifically watertight have large holes in them which allow the liquid in any tank to maintain a level between all floors. These tanks are used for storage of oil, water, etc., or can be used by filling with salt water as ballast tanks. The ship has usually several decks that run the full length. They are supported on beams that run transversely across the full width of the ship except in way of cargo hatches where they stop at the sides of the hatch.

In all weather decks these are curved up toward the centre providing drainage for water falling on the deck. The decks in the body of the ship are usually flat and do not have camber, as the curvature is called. The deck beams are supported at the end by brackets that rivet to the side frames and in the central portion of the ship by heavy girders running longitudinally. These girders are so placed that they form the sides of the hatches and the short beams have their inboard ends framed into them. In turn the girders are supported at their ends by brackets to bulkheads and at hatch corners by heavy built up columns. Between the tank top or inner bottom and the lower deck and between decks, bulkheads are placed at

intervals. These are composed of relatively light steel plates stiffened in the main holds by heavy channels and in the shorter ones by angles. All other details of construction follow similar lines and a further description might prove tedious.

The sizes and weights of the various members of a ship are covered by the rules and are referred to as scantlings. To enable a ready use of tables for these values certain functions of the length, breadth, and height to the lowest deck and to all other decks have been evolved. When once the above dimensions of a ship are known, the numbers are easily computed and following in order the scantlings that correspond to these numbers are found from the tables. In riveting, experience has shown that certain spacing works well, so spacing is specified as a function of the diameter of the rivet as 2½ dia., etc. The thickness of the plate as well as the working conditions require different density of rivets. Oil tight work for instance being the most exacting, as oil will pass a seam that is fully water tight.

The name Lloyds has become identified in the lay mind with ships. Originally the organization that bears that name was simply a gathering of merchants, ship-owners, underwriters, insurance brokers, etc., at a coffee house run by Edward Lloyd. While these meetings were at first very informal the nature of the business that soon began to be transacted gave the name growing significance. As early as 1688 the press took interest in Lloyds, an account of some of their activities being printed in the London Gazette in February of that year. The first printed policy covering marine losses was issued by Lloyds in 1774 and the form then adopted is substantially the same as the one in use today. In 1811 a general reorganization occurred and in 1871 a charter vesting in them all rights as a corporation was obtained through an act of Parliament.

The activities of Lloyds are varied, though they are all the results of systematic studies in an effort to classify shipping with regard to quality of construction and seaworthiness. To obtain insurance a ship must be registered by one of the societies or bureaus, such as Lloyds, The American Bureau of Shipping, etc. The operation of all these is very similar, Lloyds being the oldest and also the best known, having handled the bulk of the world shipping. Recently the American Bureau loomed up as the result of the war activities. If a ship is constructed in accordance with the rules and is inspected (called surveyed) either during

construction or subsequent to completion it is given a classification number. These rules also fix the safe carrying capacity of the ship determining the depth to which she is to be submerged when fully loaded. A mark is placed on the sides of a ship at the full load draft line and in the event that the ship owner or captain causes the vessel to be loaded deeper than this mark such action automatically cancels all insurance then in force.

The mark just spoken of is termed Plimsel Mark and is made up of a circle with a vertical and several horizontal lines. Each of these horizontal lines has a special significance though they are all placed in such a position as to give the same displaced tonnage. The upper one defines the submergence in fresh water, the lowest one in salt water of average density, while the intermediate ones apply to varying conditions, such as the one that is marked N A which applies to the North Atlantic regions where the density of the sea water is reduced owing to the presence of large bodies of ice.

Most of the recent shipbuilding activities in this country are being carried out under the rules of the American Bureau which is often called American Lloyds.

The outbreak of the war with Germany created many problems that needed prompt solution. I doubt if there was any one more vital to the winning of the war than that of building ships. All governmental activities were delegated to a group of men who operated as the Emergency Fleet Corporation. The name in itself ought to describe its purpose if that were not otherwise generally known. To obtain greatly increased tonnage this corporation selected certain types of boats as standards and then let numerous contracts for their construction.

The one that has been built in the largest numbers was the 8,800 DW Tons transverse framed freighter. In order to expedite the construction, the simplifying of details was made the preeminent requirement. In the adopted plan, the section was made practically uniform for more than half its length and while the lines so obtained are not matters of beauty, vessels of this type were being produced by many yards in rapidly increasing quantities at the time the Armistice was signed, and are giving excellent service.

To meet the demands for ships many new yards were built and as machinery was hard to obtain many turned out several ships before they were really equipped to handle the work efficiently. At the Southwestern Shipbuilding Company's yard the only

machine that was available for shaping shell plates for the early hulls was an old multiple punch gate press. This was modified and fitted up with blocks so as to handle those plates that required the most work but by far the greater number were pulled to place with bolts and jacks. When one realizes that the average thickness of these plates is in the neighborhood of 3/4 of an inch he gets a faint conception of the task involved. Despite all these difficulties by the application of engineering and science along with hard work this yard was able to launch its first boat in 65 working days. This meant that about 3,200 tons of steel were placed, bolted, and a major portion riveted in that length of time. As a matter of comparison if the above steel were loaded on standard flat cars it would take 64 of them to transport the steel for one boat.

A general description has been given of the boat and now we can take up the various steps in its production. The description given is that of the process in a yard that fabricates its own work. By fabricating is meant the punching, shearing, rolling, etc., of the plates or shapes.

The first step in the construction of a ship is the preparation of the drawings. In the hull section the computations and studies made necessary in determining the lines, displacement, etc., call for engineering and applied science of the highest order. The lines of a ship are the lines that delineate the intersections of the molded shape with a set of parallel planes. As is the case with all solids there are three sets possible in a system of rectilinear coordinates, namely length, width, and height. Ships built by either the transverse or the longitudinal system are divided longitudinally in spaces usually equal except at the ends called frame spaces. The transverse lines indicating the intersection of planes through these frame stations, at right angles to the length, with the molded shape and carrying such information as the height to the decks, etc., form what is known as the body plan. The ship being symmetrical with respect to the centre keel, it is customary to give the lines of the fore body on one side of the centre line and the after body on the other. Thus the half body fore and after plans together will give the information necessary as to transverse lines. It is this body plan that is laid down on the mold loft floor. In the drafting room to facilitate the design and computation two other sets of lines are prepared, one showing the resulting line from longitudinal sections cut by vertical planes parallel to and at

stated intervals from the centre line of the ship. These are known as shear lines. The last are what are known as the water lines. These are the sections of the ship at the water line for different depths of loading on an even keel. The last two sets are more useful in the design than at any other stage in the construction of a ship. As described before, the scantlings or dimensions of most members of a ship are determined by empirical rules. These rules are those that have been established from experience by Lloyds, American Bureau, etc., and as the stresses existing in a ship are more or less indeterminate and as the rules have been shown to give safe results, few if any computations are made on these details. When we come to the mechanical equipment we find that a similar condition exists, much of this work being based on empirical formulae, though not to the same extent as the hull.

When once the plans are prepared the process in a modern yard moves to the mold loft. The mold loft is a building with a well-matched floor on which a set of lines or body plan is laid down; they are usually drawn full size and the working templates can therefore be picked directly from the floor. Mold loft work is about as good an example as can be obtained of applied descriptive geometry.

For example, in the development of a shell plate template on a curved portion of a ship, the problem becomes one of expanding a warped surface the position and line of its intersection with several parallel planes being known. The template is constructed of light wood strips braced as necessary, only sufficient strips being used to give stock for marking the position of rivet holes. Though this development of the template is a graphical process it does not alter the fact that it is applied science. In the preparation of templates for as large a structure as a ship, engineering principles have many ready applications. Take the matter of clips alone, where two members are connected at an angle approximating 90 degrees, this is usually accomplished by the use of short pieces of angles. These angles are known as clips and by the standardizing of the hole spacing clips were developed that were generally interchangeable. This same principle was applied to the reinforcing angles on the double bottom floors. These floors are the plate girders that separate the inner bottom from the bottom shell. They are designed primarily to give transverse strength and are the continuations of the side frames in the bottom section from the bilge to the keel. Outside of a few

of these where special conditions existed they were made interchangeable and were thus designed along true engineering lines.

The finished template has small holes indicating the position of all rivets. To reproduce the template in steel it is firmly clamped down to the steel and the position of each hole is transferred by the use of a centre punch and hammer.

When all the holes have been transferred with a centre punch they are outlined with white paint and any other information necessary in the fabrication of the plates is also painted on. This process is known as laying out and when complete the plate is said to be laid out.

After leaving the layout space the plate goes to the punches, counter-sinking machines, and lastly to the shears. A countersunk hole is one that is enlarged with a conical reamer. This is done to allow the forming of a head on the rivets that will be strong, watertight and still not project above the surface of the plate. If full heads were driven on rivets on the outside of the shell, they would produce greatly increased friction. On the decks counter-sunk head rivets are required to produce an even surface and for watertightness.

In some cases planing is necessary, though usually shearing is sufficiently accurate. Those plates that have shape are formed either in a hydraulic press or in bending rolls. Neither of these machines were available when the work described as being done was accomplished on Hull No. 1. The description just given applies with equal force to shapes though in their case they are bent either in a hydraulic ram or by being heated. One of the most interesting sights in a shipyard is the anglesmith's shop where channels used for side frames are heated in a long, tubular furnace and then pulled into shape and held in this shape on a floor made up of large cast-iron blocks.

As far as punching of shapes is concerned it follows the same method as plates though in different types of machines. In cutting shapes that are not too large angle shears are used while the larger ones are cut off with the oxy-acetylene torch commonly spoken of as burned off. Plates with irregular outline are also sometimes burned to shape. The torch is also used for welding operations. Welding is often necessary and where proper ventilation can be secured is accomplished by the use of the oxy-acetylene torch. When work has to be done on enclosed portions of the ship the electric arc is used.

After all the foregoing operations are complete the steel is

said to be fabricated and is sent out to the slip. Here it is stored in racks and records kept of its location. In the yard with which I was connected a system was introduced by which it was possible to keep an exact check of the material available and by the use of an order system to have immediate control of the work at all times, even when running 24 hours a day. By the use of these Engineering methods this six slip yard was able to erect over 350 tons per day for some time, and on one day went well over 400. In erecting, the steel is placed in position and enough bolts are placed to keep it in place. After it has been placed men who are known as fitters take care of all the small details and make the whole ready to be bolted up for the riveters. In plating laps there is always a space where one plate is placed on top of another in connecting them, to fill this, steel wedges about 5 inches wide and of varying lengths are used.

They are made as thick as the abutting plate at the thick end and taper to a sharp edge. The fitters get these out by use of a piece of cardboard on which they mark the positions of the holes in the plates. The piece of cardboard acts as a template and the steel wedge is known as the liner. The greatest difficulty in hull construction was incurred in getting the work riveted up. This is extremely hard work and the men who tried to do it did not have the endurance to stay with it long in many instances. After riveting, many seams that have to be watertight are caulked. This consists of upsetting the material of one plate so it crowds in between the two.

When the ship has progressed sufficiently it is ready for launching. The stage at which this occurs in various yards is different, due to their handling equipment. Launching is accomplished in one of two ways, side or end launching. The equipment in either case is similar, consisting of two sets of timbers that are arranged to slide on one another. One set is fast to the slip while the other is built into the timbers that cradle the hull. While under construction the ship is held up by shores and blocks and just previous to launching these are replaced by blocking carried on wedges. As there are released the entire weight of the vessel is transferred to the ways and by simply starting the sliding movement with a jack the ship is launched. To facilitate this sliding the ways are lubricated with tallow or other heavy grease.

After launching the machinery is installed in most yards and the general outfitting takes place. Even in the case of cargo

vessels the equipment covers many lines. It includes driving, refrigerating, ventilating, and heating machinery, wireless, electrical, hospital, and cargo handling equipment. The installation as well as its design calls for the application of many scientific principles and the carrying out of the same exemplifies true engineering. When all the above has been placed as well as many things not specifically mentioned the ship is ready to set sail.

If there is any product, the construction of which calls for applied science and engineering it is the steel ship. It is hoped that these few words may have given you an understanding of the history and processes now used in ship construction, particularly the points relating to the practical application of the principles taught by this body of teachers in one of our largest industries.

VALUE OF THE HISTORY OF MATHEMATICAL IGNORANCE.

By G. A. Miller,

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Suppose that the unreliable portraits of Pythagoras, Euclid, and Archimedes, which appear in some of our textbooks, were replaced by a picture representing a modern high-school pupil in the act of teaching the use of negative numbers to these noted ancient mathematicians. The face of Archimedes might exhibit delight resulting from a clear insight into the importance of these numbers after the matter had received his attention. The face of Euclid might express some doubts as to the desirability of introducing these numbers into the mathematical literature, while that of Pythagoras might express deep meditations on possible and impossible meanings that might be assigned to these new numbers.

Another picture of this textbook might represent a college freshman in the act of teaching Newton some of the uses of determinants, and of telling Euler that it is unwise to regard all negative numbers as greater than infinity notwithstanding the fact that Wallis had drawn such a conclusion from the following infinite series:

$$\ldots\ 1/3<1/2<1/1<1/0<1/-1<1/-2<\ \ldots$$

This freshman might also explain to Descartes the use of the coordinate axes bearing his name and tell Euler that the sum of the series

$$\ldots\ +1/x^2+1/x+1+x+x^2+\ \ldots$$

is not identically 0 even if a part of this series can be obtained from $x/x-1$ by division, while the remainder can be obtained from $x/1-x$ in a similar way, and $x/1-x+x/x-1 = 0$ whenever $x \neq 1$.

It is naturally more pleasant to speak of the knowledge of the noted mathematicians of the past than of their ignorance. The great mathematical heritage of our times is due to thousands who worked hard to secure clearer insight and to develop better methods than those which were transmitted to them by their predecessors, and we are justly inclined to think of their contributions rather than of what they failed to see. On the other hand, it is highly desirable to use the best possible methods for acquiring a correct view of the history of our subject. Teachers cannot afford to make it more difficult for their students as a result of an undue reverence for the past.

Such pictures as those suggested above would help the student to see that mathematics is a growing science. They might help the teachers to realize anew the fact that new mathematical ideas are often acquired slowly. As the human race frequently overlooked a fruitful concept which was very closely connected with concepts already in its possession, so the individual frequently fails to grasp what seems to be so easily within his reach. Hence the teacher of mathematics may frequently gain more from a clear exposition of failures than from such an exposition of successes on the part of the eminent mathematicians of the past.

These views may be illustrated by the history of the quadratic equation. One frequently reads that the quadratic equation was solved by Euclid in his *Elements* and in his *Data*. On the other hand it is well known that the Greeks were unfamiliar with the properties of ordinary complex numbers and hence they could not have known the fundamental theorem that the quadratic equation in one unknown has always two and only two roots.

As was implied above, Euclid did not use negative numbers. In fact, he used only one root of the quadratic equation even when both of these roots are positive. With all of these evidences pointing to ignorance as regards certain fundamental facts, on the part of Euclid, one may possibly still be willing to say that he solved the quadratic equation, but it is clear that such a statement will not convey the same meaning as it would likely convey if these evidences were lacking.

A satisfactory solution of the quadratic equation was evi-

dently not possible before complex numbers were admitted to full number citizenship. As this citizenship was not granted before the latter part of the eighteenth century it might be said that the solution of the quadratic was not completed before that time, that is, until after the time when the general cubic had been solved algebraically.

Since the ordinary complex numbers are needed for the solution of the general quadratic equation, it might appear natural to assume that the introduction of the complex numbers had been due to a desire to give a satisfactory theory of the quadratic. This assumption is, however, not in accord with the history of our subject. The general solution of the cubic furnished a greater incentive for the study of these numbers than the desire to find solutions of the quadratic in all cases. The fact that when the three roots of the cubic are real, they present themselves in the form of complex numbers seems to have been especially influential in directing attention to the importance of these numbers. A knowledge of the ignorance of the ancient Greeks, the Hindus and the Arabs as regards complex numbers enables one to draw important conclusions with respect to their limitations in the theory of equations. The fact that negative numbers were not fully accepted as numbers until after the days of Descartes (1596-1650) is perhaps still more helpful for the purpose of forming a clear notion as regards certain mathematical attainments of the ancients. Such general negative facts enable the mathematical student to draw important conclusions relating to certain developments made during all the earlier periods just as general theorems enable the mathematician to deduce a large number of special theorems whenever they may be needed.

The discovery of a fundamental mathematical theorem affects mathematical history for all times. The earlier history is affected in view of the fact that the preceding developments relating to this theorem cannot have proceeded as far as the theorem. The later history is affected in view of the fact that the subsequent developments relating to this theorem were probably influenced by it. For instance, the fact that Gauss discovered that a regular polygon of seventeen sides can be inscribed in a circle by means of a ruler and compass implies that for two thousand years after Euclid had published his *Elements* the mathematical world remained ignorant of this fundamental advance in geometry. All later developments relating to this

theorem must be considered in the light of the fact that the theorem was known already by Gauss.

The value of the history of mathematical ignorance is mainly due to the fact that a knowledge of the existence of certain ignorance in reference to an important subject enables us to interpret more clearly evidences of partial knowledge relating thereto. For instance, from the fact that the Greeks knew nothing about the theory of permutation and combination, it follows that Euclid could not have made any use of the formulas of these subjects in his *Elements*. Since the Greeks did not assume that there is a (1, 1) correspondence between the points of a line and the real numbers we expect to find in these *Elements* various statements which do not agree with our modern phraseology.

In modern elements of mathematics one would expect something about logarithms and mensuration formulas but we do not expect to find these in Euclid's *Elements* since the former were entirely unknown in his day and practical geometry received little attention on the part of the Greeks until after the time of Euclid. The greatest difference between Euclid's *Elements* and modern elements of our subject relate to the treatment of numbers and elementary algebra for reasons which have already been noted. A study of Euclid's *Elements* in the light of the fact that his treatment was so seriously limited by the lack of knowledge along various lines is evidently more profitable than one based simply on what may be found in this very important work itself.

An emphasis on what was not known at certain periods is more important in the study of mathematical history than in that of the history of other sciences in view of the fact that there is such a close relation between various mathematical developments. In particular, a satisfactory discussion of the solutions of systems of linear equations implies a knowledge of determinants and the Galois theory of equations implies a knowledge of symmetric functions. One might perhaps be inclined to add that a study of spherical trigonometry implies a study of plane trigonometry, notwithstanding the fact that some of the developments in spherical trigonometry preceded corresponding developments in plane trigonometry as a consequence of the recognized usefulness of the former in astronomy.

We have thus far referred only to the mathematical ignorance common to all in the earlier periods of our civilization. The history of mathematical ignorance on the part of a large por-

tion of the educated class has not received much attention. In the preface to his book entitled *Easy Mathematics*, 1906, Sir Oliver Lodge said: "The mathematical ignorance of the average educated person has always been complete and shameless, and recently I have become so impressed with the unedifying character of much of the arithmetical teaching to which ordinary children are liable to be exposed that I have ceased to wonder at the widespread ignorance, and have felt impelled to try and take some step towards supplying a remedy."

The mathematical ignorance on the part of the average educated person may perhaps serve to explain the wide-spread erroneous view on the part of many of the ancient people, including the Greeks, that areas of surfaces are proportional to their perimeters. This view was expressed by the noted Greek historian, Thucydides, who lived about the time of Plato and assumed that the area of an island could be determined by measuring its perimeter. The Roman writer, Quintilian, in the first century of our era referred to the fact that it was easy to make people believe that surfaces have the same area whenever their perimeters are equal.

It does not seem likely that even such gross mathematical misconceptions on the part of educated people can ever be entirely eliminated. The efforts of the teachers of mathematics should be directed towards the reduction of the number of those who either hold erroneous views in regard to fundamental mathematical questions or have not acquired sufficient mathematical insight to avoid being misled as regards such questions. The main object of this note is, however, to direct attention to the fact that it is sometimes helpful to emphasize lack of knowledge on the part of the writers of a certain period in order to secure with the least possible effort a correct view of their contributions.

SOLUTION OF CUBIC EQUATIONS BY STRAIGHT LINE GRAPHS.

By M. G. Schucker,

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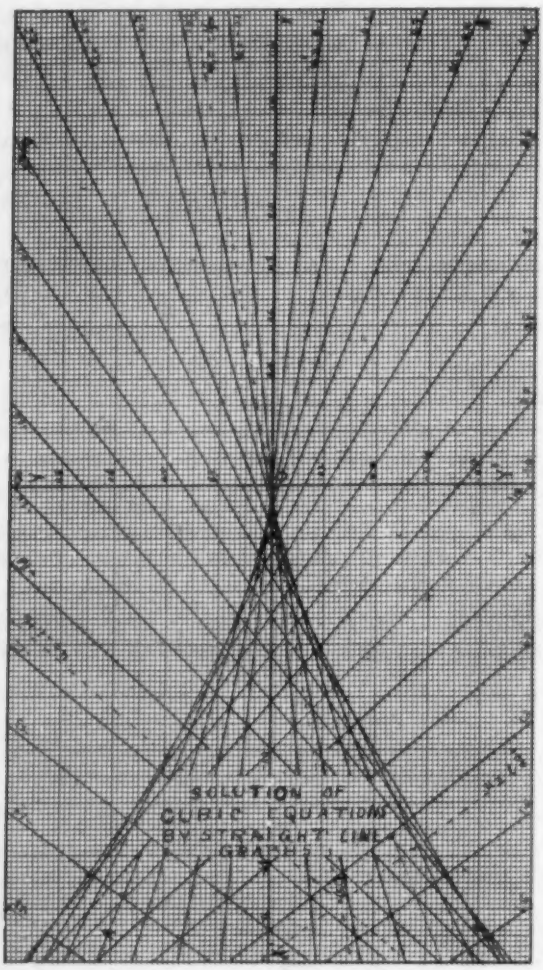
The complete cubic $z^3+az^2+bz+c = o$ may be transformed into $u^3+su+t = o$. The roots of this equation depend upon the values of the coefficients s and t. If, now, for graphical representation x is taken equal to ks and y equal to kt and substitution is made accordingly in $u^3+su+t = o$, the equation becomes $y+ux+ku^3 = o$. If u be considered a known value, $y+ux+ku^3 = o$ becomes a straight line equation in x and y



and may be represented by a series of straight lines by assigning any numerical values to u and k.

The chart represents such a series of lines, when $k = 1$ and u is given the values o, ± 0.1, ± 0.2 . . . That the construction of these lines may become readily evident, the plotting of AB and CD will be given in more or less detail. Let $u = 0.4$, then $y+ux+ku^3 = 0$ becomes $y+.4x+.064 = 0$, whose graph is AB, by using a scale for both abscissas and ordinates such that $5mm$ on the chart shall represent .1 in the values assigned to x and y in plotting. If $u = -0.6$, $y-.6x-.216 = 0$ results, giving the line CD for the graph. Since the substitution of 0.4 and -0.6 for u in the cubic $u^3+su+t = 0$ results in equations $.064+.4s+t = 0$ and $-.216-.6s+t = 0$, it will appear by comparison of these equations with equations $y+.4x+.064 = 0$ and $y-.6x-.216 = 0$ obtained above, that x and y can be interchanged with s and t, respectively.

We are now ready to use the chart for the solution of cubic equations. In the construction of the chart, values assigned to u led to corresponding values of x and y, graphically represented by the straight lines indexed according to the values of u to which they correspond and from which they were derived. Any point (x, y) in the plane may also be designated (s, t). Consequently, it will now be possible, given certain values of s and t, to trace along a straight line through a point (x, y) or (s, t) in a direction and position in accordance with lines already actually drawn and to interpolate an approximate corresponding value of u.

One example will be sufficient to illustrate this. Transform the given cubic $x^3+2x^2-5x-6 = 0$ by substituting $z - 2/3$ for x, obtaining $z^3-6.3z-2.2 = 0$. In this equation $s = -6.3$ and $t = -2.2$. But the point $(-6.3, -2.2)$ is not found on this chart. The chart can be used for values of s and t beyond its range, and the equation chosen illustrates this feature also. To bring the solution within the range of the chart, let $z = 2u$, then $z^3-6.3z-2.2 = 0$ becomes $u^3-1.57u/3-.27 = 0$, an equation corresponding to $u+su+t = 0$. By laying a straightedge along the line through the point $(-1.57, -.27)$, which is the point (s, t) for this equation, in a direction comporting with the lines $u = -1.1$ and $u = -1.2$, the value -1.16 may be approximately interpolated. Likewise, by using the lines $u = -0.1$ and $u = -0.2$, the value $-.16$ may be determined. By using the lines $u = 1.3$ and $u = 1.4$, $u = 1.3$ may be found.

Then for $u = -1.16$, $2u = z = -2.33$. $z - 2/3 = x = -3$. For the value $u = -.16$, $x = -1$; and for the value $u = 1.3$, $x = 2$. Of course, the values offered here in this sample equation are exact and obtained for the purpose of this paper by accurate and actual calculation, while such exactness is not expected of graphical computation, which is more frequently only approximate.

It will be observed that according as the point (s, t) falls outside of, on the boundary of, or within the triangular shaped region on the left, one, two, or three values of u can be read, and the corresponding cubic equation has one real root only, three real roots two of which are equal, or three distinct real roots.

The chart is merely an illustration of the method. A more elaborate and extensive chart would be accordingly more useful as, by it, it would be possible to solve cubic equations more conveniently and with a higher degree of approximation.

(Note by Math. Ed.—For other examples of the use of graphic charts see, *Graphical and Mechanical Computation*. Lipka, $4.00, 1918, John Wiley and Sons, Inc.; *The Construction of Graphical Charts*, Peddle, 1910, McGraw-Hill Book Co., *How to Make And Use Graphic Charts*, Haskell, $5.00.)

HOW TO TELL GOOD YEAST—IT SHOULD BE FREE FROM DRYNESS, GAS AND OFFENSIVE ODOR.

By Dr. Leonard K. Hirshberg.

It is a simple matter to tell the difference between good fresh yeast cakes and the huge old, dry circular loaf cakes found in a lot of New York East Side shops, and foreign groceries in other cities. Yeast cakes, wrapped in silver foil are almost unknown in these shops, as their patrons, not aware that yeast is a perishable product, do not demand fresh goods. The yeast loaf is sliced down like cheese, and slices are sold until the entire loaf is gone regardless of the length of time it lays on the counter.

Many of the upset stomachs and other digestive disturbances blamed upon one thing or another except the right cause, are really due at times to yeast used in bread, home brew and cakes, which is not the fresh grocery yeast cakes carefully kept in silver foil. The latter are supplied to dealers daily, and are always fresh.

Almost everybody eats yeast these days for beautifying the complexion, warding off sickness, and increasing their powers of endurance, etc.

It is therefore a matter of sensible precaution to follow the advice of the Bureau of Chemistry and the Department of Agriculture and see to it that you obtain the fresh, small individual cakes of yeast at a good grocery store, and thus avoid the fatalities or disturbances which pass under the blame of autointoxication, indigestion, food poisoning and the like.

In all of the experiments conducted by experts, it has been found that the large yeast masses from which foreign stores slice off, and sell dry portions, the stale yeast is not to be trusted, while the small square cakes are always safe.

In this small cake you are sure to obtain the fresh active yeast rich in water soluble vitamines, those essential elements of perfect health and activity.

THE PARALLEL DEVELOPMENT OF MATHEMATICAL IDEAS, NUMERICALLY AND GEOMETRICALLY.

By Louis C. Karpinski,
University of Michigan, Ann Arbor, Mich.

The historical development of the fundamental ideas of arithmetic, algebra, and geometry presents a beautiful illustration of the process of evolution in the realm of thought. The continuity of apparently isolated problems and processes reveals the working of law in the unfolding of mathematical ideas. In algebra and in arithmetic, but to a less extent in geometry, the development of fundamental ideas has taken place within fairly modern times, enabling one to trace the gradual unfolding of the scientific ideas involved; in these subjects the present appears as a part of a long past, directly connected with the civilizations of Orient and Occident.

Egypt has often been designated, even by her disciples of modern times, as the exponent of the practical in mathematics. Doubtless the pyramids and obelisks, as monuments to mathematics, have partially determined this view which was first voiced by the "father of history" in discussing the development of geometry as connected with the overflowing Nile. In truth, however, the documentary evidence preserved is eloquent of the purely intellectual interest of the Egyptians in mathematics.

"Find a number which added to $\frac{2}{3}$ of itself leaves, after $\frac{1}{3}$ of the resulting number is subtracted, 10." This problem, truly, and a dozen more like it in the Ahmes papyrus of about 1700 B. C., was occasioned only by intellectual needs. To solve such problems the Egyptian had a fully developed procedure leading certainly to the solution. The formulation of the problem and the conception of the process of solution mark an epoch in the intellectual history of man.

Somewhat similar problems in geometrical terms are found in early Egyptian papyri from Kahun and Illahun. These problems relate to the distribution of a given square area into two squares whose sides have a given ratio to each other. Again the formulation shows that we have here wholly intellectual problems arising from an intellectual interest in the universe of number and form.

The solution of equations appears in Egypt again in a series of problems relating to arithmetical series. Thus in one problem 100 loaves of bread are to be distributed to 5 people according to the terms of an arithmetical series, each one of the group receiving a constant amount of bread more than the preceding

one. Here, too, the problem is not a practical problem, concerned with actual affairs; it is a product of thought about numbers.

In ancient Babylon we do not find the equation, the fundamental and basic notion of algebra, playing any rôle. However, other algebraical ideas, such as connected series of numbers and tables, were developed in Babylon. Tables of numerical squares and cubes are found on cuneiform tablets; the particular arithmetical and geometrical series discovered in Babylon are given in connection with a geometrical problem on areas.

The Greek development of mathematics progressed from earliest times along geometrical rather than along numerical lines. The Greek progressed scientifically and logically much further, it must be said, than the Egyptians or Babylonians. Particularly, the Greeks early conceived the notion of a series of logically connected propositions about geometrical figures, which idea culminated in the geometry of Euclid.

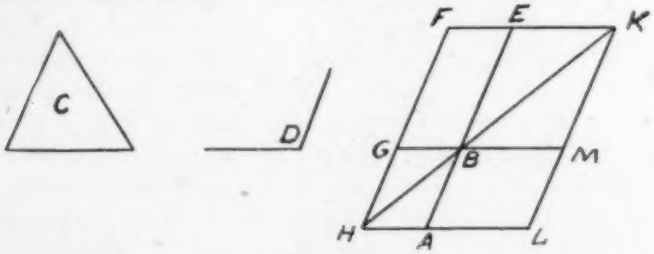


FIGURE 1

The Egyptians thought of an unknown quantity, as we have seen, numerically; the Greek conceived the unknown first as a line. Thus the Greek formulates the first degree equation in geometric language, requiring to determine the unknown side when given the area of a rectangle and one side. The actual formulation in Euclid, I, 44, is: "To a given straight line to apply in a given rectilineal angle, a parallelogram equal to a given triangle," the first of the famous problems on "application of areas." The solution of this problem is remarkable because it involves, in effect, the finding of a fourth proportional without involving the methods of propositions relating to proportion (Euclid, Book V), avoiding thus any discussion of incommensurable magnitudes.

The demonstration as given by Euclid[1] follows:

"Let AB be the given straight line, C the given triangle and D the given rectilineal angle; thus it is required to apply to the

[1]Quotations which follow are from Heath. The Thirteen Books of Euclid's Elements, Vol. I, Cambridge, 1908.

given straight line AB, in an angle equal to the angle D, a parallelogram equal to the given triangle C.

"Let the parallelogram BEFG be constructed equal to the triangle C, in the angle EBG, which is equal to D; let it be placed so that BE is in a straight line with AB; let FG be drawn through to H, and let AH be drawn through A parallel to either BG or EF.

"Let HB be joined."

Produce HB and FE to meet at K; through K draw KL parallel to EA and produce HA, GB, to the points L, M.

Then HLKM is a parallelogram.

HFK is equal to HLK, and similarly HGB to HAB and BEK to BMK. By subtraction it follows that the parallelogram ABML is equivalent to the parallelogram GBEF.

"And, since the angle GBE is equal to the angle ABM, while the angle GBE is equal to D, the angle ABM is also equal to the angle D. Therefore, the parallelogram LB equal to the given triangle C has been applied to the given straight line AB, in the angle ABM, which is equal to D."

If b and c represent respectively the sides of the rectangle equivalent to C, within the given angle, and a represents the given line, the theorem presents the solution of the first degree equation,

$$ax = bc;$$

or x is the fourth proportional to a, and b, and c, since

$$\frac{a}{b} = \frac{c}{x}$$

The whole of the second book of Euclid's *Elements* is algebraical, corresponding directly to simple theorems of elementary algebra. With the present algebraical language some of these theorems are, in fact, implicit in the symbolism, hardly capable of proof. As an illustration of the algebraical content of one of these theorems, let us examine Euclid II, 5:

"If a line be cut into equal and unequal segments, the rectangle contained by the unequal segments of the whole, together with the square on the straight line between the points of section, is equal to the square on the half of the line."

Algebraically, this proposition is simply an identity:

$$x(a-x)+(a/2-x)^2 = (a/2)^2,$$

a being any number (or line), x and $a-x$, the two unequal parts of the number (or line), and $a/2$ being half of the number (or line).

In the case of external division of the line given in Euclid II, 6, the corresponding algebraical formula is,

$$x(a+x)+(a/2)^2 = (a/2+x)^2$$

which corresponds, of course, to making x negative in the preceding formula.

With the Greek and with the Arab who made the direct algebraical application of Greek geometrical theorems, the negative quantity was not recognized as an independent entity, being always conceived as a positive quantity subtracted from another given positive quantity. The Arab made use of these two theorems, Euclid II, 5 and 6, to solve two types of quadratic equations:

$$x^2+21 = 10x$$
$$3x + 4 = x^2$$

In the first problem the Arab, who starts with the numerical problem, lets a line of unknown length represent x. Then the square upon the line represents x^2. To this a rectangle of area 21 is added, one side of which corresponds to the side of the given square. By the condition of the problem, the square plus the rectangle equals $10x$, whence since one side of the total figure is x, the other side 10. Bisecting the side of length 10, you can apply

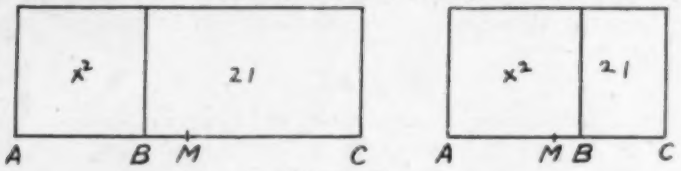


FIGURE 2

$x^2+21=10x;\ x=5+2=7$ $\quad$ $x^2+21=10x;\ x=5-2=3$

$\overline{AM}^2 = AB\cdot BC+\overline{BM}^2$ $\quad$ $\overline{AM}^2 = AB\cdot BC+\overline{MB}^2$

the Theorem of Euclid II, 5, for you have a line divided into two equal and into two unequal segments. Applying the theorem you have that the rectangle upon the two unequal segments, which is 21 by construction, plus the square of the line between the points of section, is equal to 25, the square on half the line. This gives $25-21$ or 4, as the square of that length, 2 as the length between the points of section, and $5-2$, or $5+2$, as the value of the unknown x, according as the rectangle (21) is taken greater or less than the original square.

By these two geometrical theorems Euclid presents the ideas which, expressed in algebraical language, give the solution of two types of quadratic equations. Employing this material of the Greeks, the Arab made real advance by making definite the con-

nection between the numerical and the geometrical problems.

Undoubtedly the construction of the pentagon was fundamental in the development before Euclid of Greek logical geometry. The equilateral triangle and the square, the hexagon and the octagon, can be constructed by any school-boy without particular mental effort. But the pentagon requires a different type of mathematical reasoning, including both analysis and synthesis and further a complexity of propositions not found in any other proposition of elementary geometry. With this proposition began almost certainly any wide appreciation of geometry as a logical whole, adapted for instruction.

The pentagon assumed as constructed suggests the five-pointed

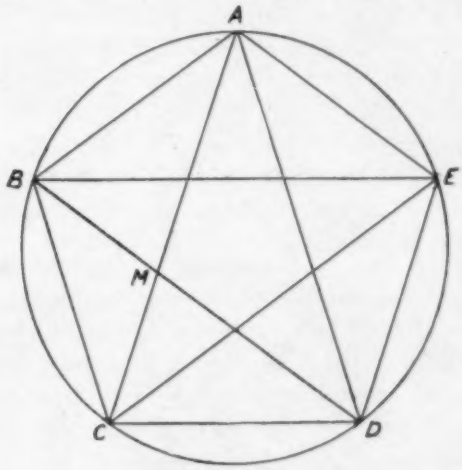


FIGURE 3

star; this being constructed the large isosceles triangle with the base angle double the vertex angle is evident on the figure (ADC); the small triangle (DMC) similar to the large triangle is also apparent in the figure; but this small triangle has as base (MC) the one segment of the side of the large triangle and as a side (MD) a line equal to the other segment (AM) of the side (AC) of the large triangle; by similar triangles,

$$MC : CD = CD : CA,$$

or

$$MC : AM = AM : AC.$$

Thus the problem to construct a pentagon is led by analysis to the problem to divide a line "in extreme and mean ratio," one segment to be to the other as the other is to the whole line. This "golden mean" is then obtained as in Euclid II, 11, by the ordi-

nary construction as given in American geometries today, and again in Euclid VI, 30, by "application of areas."

For our purpose the important point is that this fundamental proposition is, in effect, the solution of a quadratic equation,

$$(a-x)/x = x/a$$

or

$$a^2-ax = x^2;$$

the geometrical solution as given by Euclid can easily be shown to follow step by step the ordinary algebraic solution by "completing the square."

Among other primary propositions of Euclid which correspond directly to algebraical problems should be mentioned:

VI, 13, "To two given straight lines to find a mean proportional," which is the solution of the pure quadratic,

$$x^2 = ab;$$

VI, 28 and 29, "application of areas," effecting the geometrical solution of the complete quadratic equations,

$$ax-(b/c)x^2 = k^2,$$

and

$$ax+(b/c)x^2 = k^2.$$

The fact further that the Euclidean discussion of equal ratios (Euclid, Book V) is parallel to the modern algebraic theory of irrationals has already been noted by competent writers.[1]

In recent times it has been shown that only those problems are geometrically capable of solution with ruler and compass, which when expressed in algebraic language lead to problems solvable in terms of quadratic irrationalities, i. e., involving only square roots and not roots of higher order of integral functions of the coefficients. Thus the duplication of the cube algebraically gives the equation,

$$x^3 = 2a^3,$$

whose solution involves a cube root, not reducible. Similarly, the trisection of an angle leads in general to a non-reducible cubic, i. e., a cubic whose solution involves cube roots; the trisection of an angle is not possible with ruler and compass. On the other hand the equation

$$x^{17}-1 = 0,$$

is solvable entirely in quadratic irrationalities, corresponding to the fact that the regular polygon of 17 sides is constructable with ruler and compass; this 17-gon. was the discovery of Gauss while still a youth of 19 years.

[1]Simon, *Euclid und die sechs planimetrischen Bucher*, page 110; Heath's *Euclid*, Volume II, pages 124-126.

The analytical geometry and the graphical representation of complex numbers, so-called "imaginaries," are both intimately connected with this geometrical algebra, and those who are familiar with these subjects will appreciate the connection without further explanation. Suffice to say that modern mathematics begins really with Descartes and the complete algebraic treatment of geometrical problems, continued by Newton and Leibniz in the calculus.

The Arabs systematized the algebraic material, adapting it for elementary instruction by writing text-books on the subject. Further than this, the Arabs contributed materially to the fruitful union of algebra and geometry, including the systematic exposition of trigonometry which is also a type of study involving geometrical with arithmetical material.

The first treatise on algebra, *algebr w'almuqabala*, whence the name, was written by Al-Khowarizmi about 825 A. D. Less than a century later one Abu Kamil wrote a much longer treatise in which the important advance was made of the systematic solution of equations in quadratic form ($ax^4+bx^2 = k$, etc.). Al-Khowarizmi had solved quadratic equations geometrically, as indicated above; Abu Kamil solved geometrically not only for x (*shai*) but also geometrically for x^2 (*mal*). With our symbolism the connection between x and x^2 is so patent that this solution both for x and for x^2 is useless; this innovation made by Abu Kamil, adopted a century later by Al-Karkhi, was away from the path of progress, and was not continued by European writers.

About a century after Abu Kamil, the great poet and equally great scientist, Omar Khayyam, began a systematic study of cubic equations. He achieved, apparently independently of Archimedes, a solution by the intersection of conic sections. Certainly his solution has this merit as opposed to that of Archimedes that Omar presented the cubics as a continuation of the quadratic equations. The problem as set by Archimedes was to cut a sphere by a plane into two segments whose volumes should have a given ratio; of this Archimedes gave a solution. Even before Omar's discussion of the problem of the cubics an equally noteworthy step in analysis was made by an Arab in the reduction of the problem of the trisection of an angle to a cubic equation.

Another Arabic work along this line to which I wish briefly to call attention also marks progress in the union of algebra and geometry. The title of this unedited work is "Liber in quo

terrarum corporumque continentur mensurationes abhabuchri qui dicebatur heus. Translatus a magistro Girardo Cremonensi in toleto de arabico in latinum abreuiatus." The manuscript which I am using is MS Latin, Paris, 9335, Vol. 116r-126r.

The otherwise unknown author treats a large number of problems on areas and lines, stating "secundum aliabram" or "fac ergo secundum quod processit in questionem aliabre sexta et almuchabala."

Thus the first problem reads to find the side of a square when the area plus the side is given; given the area plus the side equals 110, he obtains the equation "census et res qui equantur centum et decem," i. e., $x^2+x = 110$. The solution is precisely as given by Al-Khowarizmi. The numbering of the types of quadratics also follows Al-Khowarizmi. "Restaura igitur et oppone," is a phrase employed in this work following the terminology of the writer of what may be termed the first text-book on the subject; the words "restore" and "oppose" are translations of Arabic words derived from the same stems as "algebr" and "almuqabala."

The problems which are given by this Abu Bekr are extremely simple. Nevertheless, we have here definite advance in the algebraical treatment of another type of geometrical problems differing from those given by Al-Khowarizmi and Abu Kamil.

In Egypt and in Babylon and in India also we find numerical discussion of several types of algebraical problems, involving in particular cases geometrical areas considered numerically. In Greece similar fundamental ideas were considered primarily from the geometrical standpoint. The contribution of the Arab consisted largely, but by no means wholly, in combining the achievements of the Egyptians and Babylonians and more particularly those of the Hindus and the Greeks. The transmission to Europe of the Arabic mathematical works, in translation, furnished the stimulus for the solution of the cubic and the biquadratic, as well as for the literal algebra of Vieta. Combining this algebraical material anew with the consideration of the geometrical problems on conics furnished by the Greeks, Descartes and Fermat, in the first half of the seventeenth century, discovered independently of each other the analytical geometry. With this union of algebra and geometry modern mathematics had its birth.

PROSE PROBLEMS OF ALGEBRA.

By Jos. A. Nyberg,
Hyde Park High School, Chicago.

In two previous papers the writer discussed various problems of algebra whose solutions could be facilitated by using a chart or diagram for the tabulation of the given information. The present paper is hardly more than a collection of miscellaneous remarks and suggestions on problems for which a chart is not essential.

1. Consider first a problem dealing with three or more things, such as:

"The area of Nebraska exceeds the area of Virginia by 34,893 sq. mi.; the area of California exceeds three times the area of Virginia by 30,416 sq. mi., and the area of California twice the area of Nebraska by 3,257 sq. mi. Find the area of each."

The ordinary solution would be:

Let x = area of Virginia.
Then $x+34{,}893$ = area of Nebraska.
and $3x+30{,}416$ = area of California.
$3x+30{,}416-2(x+34{,}893) = 3{,}257.$

. . . . . .

$x = 42{,}627$ = area of Virginia.
$x+34{,}893 = 77{,}520$ = area of Nebraska.
$3x+30{,}416 = 158{,}297$ = area of California.

The precise logic is so evident that it suggests a proof in geometry and one wonders why no one has suggested that the pupil write "quod erat reperiendum" at the end. We know that every geometrical proof involves two steps: The pupil's analysis which he must make for his own benefit to discover the various steps, and the pupil's presentation of the proof which, we might say, is for the benefit of a doubting audience. The solution of the above problem is similarly a presentation. To teach *analysis*, which is necessary before such a presentation can be made, the following method is suggested, the italicized words being the rules which are dictated to the pupil and kept by him for ready reference.

First, *write in a vertical column the various items* (area of Neb., area of Vir., . . .) *which the problem talks about*, writing them in the order in which they are mentioned, and placing after each an equal sign. Placing the equal sign after the item instead of to the left may seem like inconsequential quibbling but it does have some advantages, which will be seen later.

Next, *one of these items we* will *call* x, and *the others will* then

be a combination of x and other numbers. If we were clever enough any one of them could be called x; however, *choose the smallest one* if you can decide which is the smallest; if not, *call that one x to which the others are compared.* The pupil has now written what may be called the "preliminary step." The rest of the information in the problem leads to an equation and is a problem of direct translation; *the preliminary steps make the lexicon which tells how to translate into the language of algebra certain English words.* After finding x from the equation, the pupil returns to the preliminary steps to complete the problem which will then appear thus:

Area of Nebraska $= x+34{,}893 =$ 77,520 sq. mi.
Area of Virginia $= x =$ 42,627 sq. mi.
Area of California $= 3x+30{,}416 =$ 158,297 sq. mi.
$3x+30{,}416-2(x+34{,}893) = 3{,}257$

. . . . . .

$x = 42{,}627.$

This arrangement of the work with its omission of "let" and "then" does not appear on paper as logical as the first solution, but the order in which the pupil has written down his thoughts has made the work easier for him. Logical thinking is something to be acquired, and our methods ought not to be based on the assumption that the pupil is capable of logical thinking. Also, by returning to his preliminary steps the pupil is reminded that a problem does not end when merely x has been found. Further, in the problems which involved the use of charts, x and its combinations were written in a column at the right of the various items; the same idea is used here. The similarity of the analysis of those problems and the present one is evident. Underscoring the final answers or placing square brackets around them, besides being a common practise wherever computational work is done in engineering and statistical offices, is a good habit for the pupil—he finishes the problem with a stroke that makes him feel something valuable has been accomplished. The writer also believes that the foregoing rules are easier to understand than the rules found in most algebras.

2. A single problem can be used to teach a great many things. Consider for example:

"Mr. Brown can allow his three children all together a dollar and a half per week for spending money. In order to pay his carfare John needs 50c per week more than Elizabeth, while

James requires only half as much as Elizabeth. What allowance will each child receive?"

The pupil writes in a column: John, Elizabeth, James, with an equal sign after each. Then he writes x in the third line as James receives the least, $2x$ after Elizabeth, and $2x+50$ after John. After the solution has been written on the blackboard, the class is asked how Mr. Brown might solve the problem without any knowledge of algebra. Naturally by trial or guess; and his calculations would appear thus (the teacher writing Mr. Brown's attempts alongside the work already on the board):

John	$= 2x+50$	$=$	90	70	110	80	100	90
Elizabeth	$= 2x$	$=$	40	20	60	30	50	40
James	$= x$	$=$	20	10	30	15	25	20
Total	$= 5x+50$	$=$	150	100	200	125	175	150

The class will then see that among other things, algebra eliminates guess work by its substitution of a letter x for the trial number. Dividing the class into two parts, one half to work by algebra, the other half by arithmetic, let them experiment and see which can determine quickest the various disbursements, if Mr. Brown has 2.95, 3.35, . . to distribute. In attacking any set of new problems where the first ones can be done by arithmetic, it is well to use arithmetic and not discourage its use. Too often in geometry classes a pupil works a problem by algebra when he needs only elementary arithmetic, as for example, when dividing a line 16 inches long into two parts whose ratios shall be 4:3. Of course, the exercises must be so graded that the pupil finally comes to one where he must resort to algebra. Many "time, rate, and distance" and "work" problems can be done by arithmetic, and it is always worth while doing some by that method. The fact that fewer pupils in the class may be able to do the arithmetical reasoning and that the method will be harder for the rest of the class to grasp, will be good arguments for the use of algebra. The class will eventually carry away the notions that algebra eliminates guess work, is a last resort when arithmetic fails, and (regarded as a machine) is easier to understand and manipulate than arithmetic.

But this is not all that can be learned from this problem. Suppose we call the distribution y, so that $y = 5x+5$. The class can see from the figures above that the value of x decides the value of y, and that similarly the value of y (the amount to

be distributed) decides the value of x (what James gets). It would be unsound pedagogy to introduce the word *function* but we have here all that the word function implies and we can enlarge on the idea much or little according to the abilities of the class. Certainly it ought not to be passed over without some comment. And if from time to time the pupil's attention is called to such mutual dependences, the explanations which come later will have acquired a meaning, and the teacher will have a foundation on which to build. Even at the risk of interrupting the next day's assignment the class should occasionally be asked to make a more complete table of corresponding values of x and y.

3. In dealing with problems containing a single unknown number we translate the English into the language of algebra. Exercises which reverse this order should also be tried. Thus: The equation $(x-5)\div 6+3 = 2x+7$ was derived in a problem. What was the problem? The pupil answers: If a sixth of a certain number when decreased by 5 is added to 3, the result equals, etc. An occasional five or ten minutes practice on such a translation of a list of exercises, particularly those involving fractions, has its usefulness. For one thing, the pupil will need to watch his English to avoid ambiguity. The above translation, for example is a poor one because it does not state clearly whether the number is divided by 6 before or after the decrease by 5. It is not amiss to assume that this practise will teach him to observe more carefully the wording of the prose problems of the text.

Any equation containing only x may be presented as a conundrum. Thus during the first weeks I say "I am thinking of a number. If I double it, add 10, and divide by 6 I get 5. What number am I thinking of?" In this connection it is also useful to work some of the old parlor games such as: Ask a pupil to think of any number; keeping the number secret, have him multiply it by 5 add 6 divide by 8 and then ask him for the resulting number. The original number can then be determined. The game sounds trivial to an experienced teacher who has forgotten how he himself learned algebra, but to the freshman it is nothing less than wonderful. The process may then be reversed by writing an equation on the board and asking for a statement of the directions to be followed by the computer in determining the original number. This work will involve the substitution of a number for a letter in a polynomial.

From this as a basis we can introduce the evaluation of polynomials for a given value of x.

4. Frequently in explaining some problem or method a happy choice of simile or metaphor will not only remove difficulties but make a lingering impression on the pupil. The public orator never hesitates to clinch an argument with a suitable comparison, but our mathematical text books contain very few. It would seem as if the writers feared losing their dignity. Hence, fully realizing any such possible loss, I add the following illustration. To solve the equation

$$6(3x-2)-5(2x+1) = -4(5x-3)+83$$

we imagine ourselves in the place of a grocery clerk in the shipping department, say, who receives from the wholesaler three kinds of packages. He gets 6 of one variety labeled as containing* $3x$ and -2; he gets -5 of another variety containing $2x$ and $+1$, and -4 packages of another variety; also, a $+83$ unwrapped. To examine the goods he must *unwrap the packages, having then*

$$18x-12-10x-5 = -20x+12+83.$$

His next work would be to *sort the various goods* putting the x in one pile, the constants in another just as if sorting apples in one bin and potatoes in another. Hence the pupil writes:

$$18x-10x+20x = 12+5+12+83.$$

In the transposition, certain signs are changed, of course—which is one way in which algebraic quantities differ from apples. *After sorting, the clerk counts how many* apples *he has,* how many potatoes, etc.; and so the pupil's next duty is to count how many x's he has, how many constants. Hence $28x = 112$. We see that the illustration can not be carried too far, but the pupil will see that he (1) removes parentheses by multiplication, (2) rearranges by transposing, (3) simplifies by addition, and (4) finds x by division.

Another illustration occurs in handling radicals. When it becomes necessary to simplify radicals I personify the radical sign comparing it to a very fastidious landlord who will not shelter a tenant who is a fraction or is divisible by a perfect square. If a pupil forgets to simplify such a quantity I have merely to say "Consider your fastidious landlord." I have heard of a teacher who compares the perfect square factor of the radicand to a beautiful princess imprisoned in a tower from

*The writer does not regard $3x-4$ as the subtraction of a 4 from a $3x$ but as the addition of a $3x$ and a -4. See the paper "Plus and Minus Signs in Algebra" in the May issue.

which she is to be brought outside by a knight, the pupil. And the linear relation which can sometimes be derived from a set of simultaneous quadratics is a "Wandering Willy" lost and concealed in a forest of x's and y's. Undoubtedly many teachers use such comparisons. It is unfortunate that the textbooks on pedagogy do not contain a collection of these useful comparisons.

5. Every text when considering equations divides the work into two parts, the exercises and the problems. The exercises are the equations for whose solution certain directions are given. Then as an application these exercises are followed by problems (variously called "prose" problems or "word" problems) leading to equations of the type which the exercises have illustrated. This is the usual order in the chapter introducing parentheses, or when fractions are first used, or in the chapter involving quadratics, etc. This order is regarded as necessary for unless the pupil knows how to solve a certain type of equation, he can not complete the problem. To consider the problem first would also have its advantages because it is concrete whereas the exercise involves an abstract x, and because it would justify the study of the new equation by showing how it arises. Hence I have tried the following combination of the two methods. I consider the problem first, discuss the unknown element, the given information, and derive the equation. I treat in this way all the problems that I intend to assign and set each equation aside (writing them in one corner of the blackboard) for future reference, pleading inability to solve it because of insufficient knowledge of algebra. Then, after making a list of the equations, I ask in what way these equations differ from previous ones. After fixing the attention on the parenthesis, or the denominator, or the quadratic term we begin the study of the equation and work the exercises, returning last of all to the problems again. At times several days or a week may intervene between the first time the problem is studied and the final solution of it. But this plan keeps a single definite object before the pupil at all times, concentrates the attention on the new element as it arises, and emphasizes the idea that the solution of the problem is the important end, that the equation is a means or tool for that end, and that all the rest of the work is intended to develop proficiency in handling the equation.

6. The first months of algebra contain many problems involving two unknowns wherein the sum of the two is given;

and one of the most difficult ideas for the pupil to grasp and use is that if the sum is 60, for example, and one unknown is called x, then the other must be $60-x$. Usually a text leads up to this quantity $60-x$ by various questions (all of which the pupil may answer correctly, and still the next day use $x-60$ instead of $60-x$) or else impresses it by writing

$$\begin{aligned} \text{smaller number} + \text{larger number} &= 60 \\ x \qquad\quad + \text{larger number} &= 60 \\ \text{larger number} &= 60 - x \end{aligned}$$

which is a good method if transposition has already been considered (as the writer believes it should be). But after many attempts the writer has found that the easiest method is to use two letters x and y, and let the pupil write $x+y = 60$. This involves an early use and solution of linear simultaneous equations. Why not adopt the principle that no method should be taught which will subsequently be replaced by an easier one unless the first method teaches something which the pupil can not learn from the second. In other words, no method is to be studied and used for itself alone, but only for what it can contribute toward a solution of a problem. It would seem then that the prose problems of the first months of algebra which require a good bit of explaining and which can be solved more easily by simultaneous equations either ought to be omitted entirely or else solved by simultaneous equations. It is possible to organize the first year of algebra in such a way that almost all of the first semester's work will be devoted to the study of equations and problems leading to equations. To the second semester we could postpone all multiplication of binomials, division of polynomials by binomials, and all the work on factoring. In their place we would then have equations involving fractions with numerical or monomial denominators, their numerators being binomials. And such an arrangement would give ample time for simultaneous equations earlier in the year.

A STUDY IN DETERMINANTS.

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In solving by determinants the following rule is given: "Any unknown is equal to a fraction whose denominator is the determinant of the system and whose numerator is the determinant formed from the determinant of the system by substituting for the coefficients of the unknown sought the corresponding known

terms with that sign attached to each known term which it has when on the side of the equation opposite the unknowns."

In the above rule let x be the unknown, N the numerator of the fraction, and D its denominator.

Evidently we have the following:

$$x = \frac{\begin{vmatrix} k_1 & b_1 & c_1 & \cdot & \cdot & \cdot & l_1 \\ k_2 & b_2 & c_2 & \cdot & \cdot & \cdot & l_2 \\ k_3 & b_3 & c_3 & \cdot & \cdot & \cdot & l_3 \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ k_n & b_n & c_n & \cdot & \cdot & \cdot & l_n \end{vmatrix}}{\begin{vmatrix} a_1 & b_1 & c_1 & \cdot & \cdot & \cdot & l_1 \\ a_2 & b_3 & c_1 & \cdot & \cdot & \cdot & l_2 \\ a_3 & b_2 & c_2 & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ a_n & b_n & c_n & \cdot & \cdot & \cdot & l_n \end{vmatrix}}, \text{ or } x = \frac{N}{D}.$$

Obviously N and D differ only in the first columns.

From $x = \frac{N}{D}$ we get $xD = N$ and subsequently $xD - N = 0$, where D is not 0. xD may be expressed as a determinant by multiplying each element of column one in D by x, for, if all the elements of a row (or column) of a determinant are multiplied by the number x the determinant is multiplied by x.

$$\therefore xD = \begin{vmatrix} a_1x & b_1 & c_1 & \cdot & \cdot & \cdot & l_1 \\ a_2x & b_2 & c_2 & \cdot & \cdot & \cdot & l_2 \\ a_3x & b_3 & c_3 & \cdot & \cdot & \cdot & l_3 \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ a_nx & b_n & c_n & \cdot & \cdot & \cdot & l_n \end{vmatrix}.$$

Likewise $-N$ may be expressed as a determinant by multiplying all the elements of column one of N by -1. Thus:

$$-N = \begin{vmatrix} -k_1 & b_1 & c_1 & \cdot & \cdot & \cdot & l_1 \\ -k_2 & b_2 & c_2 & \cdot & \cdot & \cdot & l_2 \\ -k_3 & b_3 & c_3 & \cdot & \cdot & \cdot & l_3 \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ -k_n & b_n & c_n & \cdot & \cdot & \cdot & l_n \end{vmatrix}$$

Substituting in the equation $xD - N = 0$ we get,

$$\begin{vmatrix} a_1x & b_1 & c_1 & \cdot & \cdot & \cdot & l_1 \\ a_2x & b_2 & c_2 & \cdot & \cdot & \cdot & l_2 \\ a_3x & b_3 & c_3 & \cdot & \cdot & \cdot & l_3 \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ a_nx & b_n & c_n & \cdot & \cdot & \cdot & l_n \end{vmatrix} + \begin{vmatrix} -k_1 & b_1 & c_1 & \cdot & \cdot & \cdot & l_1 \\ -k_2 & b_2 & c_2 & \cdot & \cdot & \cdot & l_2 \\ -k_3 & b_3 & c_3 & \cdot & \cdot & \cdot & l_3 \\ & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ -k_n & b_n & c_n & \cdot & \cdot & \cdot & l_n \end{vmatrix} = 0.$$

The above is the sum of two determinants which differ in one column only, and can be expressed as one determinant by changing a_1x, a_2x, a_3x, etc., to a_1x-k_1, a_2x-k_2, a_3x-k_3, etc. This is in conformity with the rule which states that if one row (or column) of a determinant has as elements the sum of two or more numbers, the determinant can be written as the sum of two or more determinants.

Call the new determinant E.

$$E = xD - N = 0, \text{ or}$$

$$E = \begin{vmatrix} a_1x-k_1 & b_1 & \cdot & \cdot & \cdot & l_1 \\ a_2x-k_2 & b_2 & \cdot & \cdot & \cdot & l_2 \\ a_3x-k_3 & b_3 & \cdot & \cdot & \cdot & l_3 \\ \cdot & & \cdot & \cdot & \cdot & \cdot \\ \cdot & & \cdot & \cdot & \cdot & \cdot \\ a_nx_n-k_n & b_n & \cdot & \cdot & \cdot & l_n \end{vmatrix} = 0.$$

Thus $E = 0$ gives a simple equation in x from which x can be found by one determinant instead of two, as in $x = \frac{N}{D}$.

Another advantage is that E being zero, m times any column (of row) may be added to n times any other column (or row), also any column (or row) may be multiplied by m; m and n being two real numbers not zero.

After x has been found from $E = 0$, then y, z, w, etc., are found by the same method, using one column and one row less each time.

Let us solve by the above theorem the following:

$$\begin{aligned} 4x-3y &= 5. \\ 8x+y &= 17. \end{aligned}$$

Solving for x:

$$E = \begin{vmatrix} 4x-5 & -3 \\ 8x-17 & 1 \end{vmatrix} = 0.$$

$$\therefore \quad 4x-5+24x-51 = 0.$$

$$28x = 56.$$

$$x = 2.$$

Solving for y:

$$E = \begin{vmatrix} 4 & -3y-5 \\ 8 & y-17 \end{vmatrix} = 0.$$

$$\therefore \quad 4y-68+24y+40 = 0.$$

$$28y = 28.$$

$$y = 1.$$

THE PLACE OF NATURE STUDY IN THE ELEMENTARY SCHOOL CURRICULUM.

By S. H. Williams,

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The development of esthetic appreciation in any individual is closely associated with the elevation of mind to a higher plane of moral ethics.

In no other way can this appreciation be greater imbued than by introducing to the individual the wonders of the natural world. This introduction should be made early in his life, just as is the training in morality, ethics, and social responsibilities, and proceed through successive stages of intensive observation to and through adolescence when, by virtue of previous training, he will continue his observations and investigations with a manifest interest which will lead him into realms of Nature's glory and closely associate him with that divine power which has made all things possible.

We have made one advance in this direction by shifting the study of natural science from the college to the secondary schools where Chemistry, Physics, and Biology are taught sometimes in, I am afraid, a rather indifferent way. We have further broadened our vision and established a course in General Science in the first year of the secondary schools. Of course the Science has not yet reached its plane of perfection or greatest usefulness but its progress indicates that it will shortly attain an effectiveness that will emphasize its importance.

It is true that the place Natural Science now holds in the curriculum of the various grades of schools, has been made possible after a long and bitter struggle against the inertia of prejudice and routine but the victory has been a glorious one.

But why stop here? To postpone the revelations of Science until the adolescent period is analogous to beginning the study of the history of civilization at the sixteenth century without reference to the preceding ages through which it has evolved and from which the greater part is inherited. Or like beginning Algebra at Quadratics. Furthermore when a child reaches the age of puberty he has passed the age of "inquisitiveness," during which he has made our lives miserable with his incessant propounding of questions relative to the moon, stars, the rainbow, clouds, colors and odors of flowers, the birds, and a multitude of other things which only the imaginative, wondering, unconcentrated mind of a child could think of—oft times to our shame

and embarrassment at being unable to explain them. As a consequence, we ourselves can remember how our desires to know these things were suppressed by a "run along and play I'm busy and don't (emphasis on the don't) ask so many questions." This remark was often accompanied by the quotation of the old saying, "A fool can ask more questions than a dozen wise men can answer." But these questions are not foolish and we should see to it that the parents and teachers of the future will be able to answer them and enlighten the questioner as well as to encourage him in his desire to know.

Isn't it logical that this period is the time of times to make the introduction of the charms and wiles of Mother Nature to the youth?

Then why wait until the boy and girl have reached the High School, where they are confronted with the cold indifferent facts of Chemistry and Physics, before making their debut in the field of Science? Why waste the golden opportunities in child life when their very souls are burning to know—to learn—to love?

There is a saying that "It is hard to teach an old dog new tricks," and as certain as are the immortal truths of Geometry is it that after the child has reached adolescence it is harder to interest him in a new field. This is partly because he has become indifferent to the things which have been a part of his environment all his life and he has learned to take them as a matter of course. This would be a sad and sorrowful world if the training in morals and religion were postponed until this time. But if the secrets are revealed during his early life—how they grow, how the desire to know and learn more will manifest itself in productive effort.

Therefore it is advisable that a course in nature study be incorporated in the elementary school curriculum. Connect the collegiate and secondary courses with a primary foundation and they will be productive of more good.

The traditional method of introducing the Sciences into the schools first from the university to the college and from the college to the secondary schools has been like starting to build a chimney from the top downward and unlike any other subject that has ever received a place in the course of study. We do not begin mathematics at Calculus but proceed from the most elementary foundation. Neither do we begin Latin by reading Horace. So we must have a gradation of subjects in Science.

We must lay a foundation on which to build and proceed carefully to construct a stable, thorough knowledge which will precede a higher step on the ladder of learning.

It is easy to assert that the course should be given but when the matter of what it should contain is considered it causes no little concern for each teacher of Science has a different idea of the content. There are so many wonderful things in nature that it is difficult to choose those things which are of most worth. But one thing at least will be agreed upon; the course should contain elementary explanations of things which are constantly before the student, the common things, if you please, the knowledge of which will aid him in his struggle for existence and develop in him that esthetic appreciation, which is so valuable an asset to any individual and to the group.

In the elementary grades stories of animals, plants, and natural phenomena, told in the same way and in the same language as the "Uncle Remus" tales, or in the form of the beautiful story of the "Two Rain Drops" which was written by Doctor F. B. Pearson, former Superintendent of Public Instruction, in Ohio, could be used to advantage. These stories could replace, to a certain extent, the mythical tales about Santa Claus, etc., which lead the child to believe in something with so strong a conviction that when he learns that his idol is imaginary and false it causes utmost grief. I know of many a child who has cried as though his little heart would break when informed that there was no such a being as Santa Claus.

There may be some who will ask how much of this will be remembered by the child after years have gone by when he will be called upon to utilize this knowledge. I would answer such a person in a truly American fashion of answering a question by asking one. How much does he remember of anything he has studied? Furthermore how many of us have studied Mother Goose since the days of our childhood yet in the entertainment of our children we can sing and recite those little songs and stories by the hour. There will be some who can and will make rhymes of some of this information, although that would not be my idea for I believe we agree with Oppenheim that rhymes are the hardest things for a child to learn and understand. We do not want the facts to be learned in a sing-song manner but rather told and learned in a way which the word learn implies. Nor do I wish to eliminate the little fairy tales which mean so much to the child in the period of "make believe," for I love

children too much to rob them of any of their joys. But the truth, if properly told, is more fascinating than fiction and will do infinitely more good.

In the intermediate grades school gardens, home experiments, and school projects may be utilized. In the Grammar Grades laboratory and field work may be ably done and insect collections made. That this motivates the work in the whole school is subscribed to by many schools in the United States where this is in part carried out.

I shall not present here my outline of the course for the various grades, as it is not my intention to thrust upon others my ideas as to content but rather to present an argument for the course which should be standardized by the blending of ideas of a large number of capable teachers and students. There will be a tendency, no doubt, as was the case in General Science, to emphasize the divisions of Science in which the writer of text books is especially versed or interested. But no course of study has ever stood the test of time but has been subjected to the tests of usefulness and efficiency. So, too, the work in Nature study will be tested and varied until its plane of greatest good has been determined. It will be the object of criticism and ridicule, but like the others it will soon, perhaps sooner than we think, find its channel and when this has been accomplished; when it begins to function properly, this old world of ours will be a better place in which to live.

THE OUTLINE OF A COURSE IN PRACTICAL CHEMISTRY FOR GIRLS.

By Charles E. Dull,

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Feeling that the college preparatory course in chemistry does not meet the needs of students who enter business directly from high school and that it is not well suited to girls who enter normal school, we are giving courses in chemistry which we believe such students will find of more value to them than the regular preparatory work.

In the chemistry for girls, the nature of chemical action, how chemical changes are brought about, and the demonstration of the various classes of chemical change are taught in practically the same manner as in the regular preparatory chemistry.

In the study of oxygen and hydrogen, their preparation is left entirely to the laboratory. In discussing their properties,

emphasis is placed upon the special properties which make them fitted for certain uses.

After the general properties of an acid have been discussed and demonstrated, several samples are shown, including not only the strong mineral acids, but such acids as boric, acetic, citric, tartaric, tannic and oxalic. Since practically all of these are found in every household, their occurrence and uses are studied briefly at this time.

In a similar manner the general characteristics of bases are taken up. The vigorous action of soluble bases on fats and oils is briefly considered. With these bases aqua ammonia as a weaker base is contrasted. Demonstrations are used to show that washing soda, borax and soap have an alkaline reaction in solution, thus explaining their action as solvents of grease.

Eight or ten salts are used to show the variation in color, solubility, crystalline structure and chemical behavior which leads to so many different uses.

The question of theory is rather a difficult one in such a course. It seems to me that each pupil should have a clear conception of atomic weight, the atomic theory and the law of definite proportions. Each one should know the significance of symbols, and formulas, and be able to interpret equations. I expect the pupils to know how to find the molecular weight of a compound from the tables of atomic weights, to figure its percentage composition and to solve simple problems involving chemical equations.

I treat nomenclature quite as fully as in the regular course and valence a little more briefly. The treatment of solutions does not vary from that of the regular course.

The subject of fuels and illuminants is considered with combustion and oxidation. Wood, the various kinds of coal, oil and gas are compared with respect to cost, fuel value and waste products. If the class has not studied physics, we include diagrams showing the proper regulation of drafts, check-drafts and dampers. Diagrams of smoke consumers are used to show the effect of more efficient oxidation. These topics include the principles of extinguishing fire; applications of the three methods; and references to fireproof materials and the fire-proofing of cloth.

The operation of the bunsen burner is compared with the ordinary gas burner to show how to secure the highest efficiency. Coal-gas, water-gas and acetylene are studied as fuels and il-

luminants. Comparison is made between the fish-tail burner and the gas mantle as to efficiency.

In the lesson on the composition of the air, no difference is made except the greater emphasis upon methods of ventilation, the use of ozonized air and the effect of relative humidity.

In the chapter on water, the color, odor, and turbidity are first studied. The distinction between pure and wholesome water is emphasized as well as the effect of organic matter in drinking water. Natural soil filtration, mechanical filtration, boiling, aeration, coagulum precipitation and distillation are studied in their relation to water purification. The use of ozone, chlorine, and copper sulphate as methods of chemical purification are discussed. This chapter also includes such topics as the value of hard water for drinking purposes, its disadvantages for use in laundries, dye-works, paper-mills and steam boilers, and the methods used for softening hard waters.

Considerable attention is given to the study of foods, including the following topics: Starch, its occurrence and conversion into glucose and dextrine; the occurrence of several sugars and their importance as food; proteins as found in meat, eggs, flour, milk and legumes; the occurrence and extraction of fats and oils; and emulsions and saponification.

Following a comparison of the values of the various methods of cooking, the need for preserving foods that are not to be used for immediate consumption is shown by a brief discussion of molds, yeasts and bacteria. Especial emphasis is placed on the study of conditions favorable to their growth; this is followed by a discussion of the various methods of preservation: Canning, the use of sugar, pickling, smoking, drying, refrigeration, sterilization and pasteurization of milk, and the use of chemicals.

Some of the important foods are studied in greater detail. In bread-making the study of the action of yeast is followed by a discussion of the action of such leavening agents as baking powder, soda and sour milk, molasses, or simple aeration. The use of shortening is briefly discussed.

The value of milk as a food includes a study of its source, how easily it may be contaminated, souring due to lactic acid bacteria, and certified and condensed milk. Such foods as cream, ice-cream, butter and oleomargarine are studied in class. A brief study of such beverages as tea, coffee, and cocoa is included at this time. In the study of foods the most common adulterants are discussed, the nature of adulterants, and the objections to their use; whether injurious or a cheaper substitute.

Since several organic substances find extensive use in the home or the arts, the properties and use of the following are taken up: Grain, wood and denatured alcohol, carbolic acid, glycerine, formaldehyde, chloroform, iodoform, carbon tetrachlorid, and a few esters and organic acids.

Under textiles we study the source of the various fibers and the action of chemicals on these fibers. This furnishes us a basis for the laboratory tests for these fibers and also makes the chemistry of bleaching and stain removal more intelligible.

In the study of laundering the methods of making soap are considered, the quality of soap, the action of free alkali, adulterants and fillers, the use of special soaps and cleansing agents and the need for the use of bluing, and the action of the various kinds.

The study of paints, oils and varnishes includes a comparison of zinc and lead as paint bases, the action of linseed oil, the use of pigments, stains and driers, and a discussion of the various kinds of varnishes.

Comparatively little time is given to the study of the metals. The physical and chemical properties that make such metals as tin, lead, iron, zinc, silver and aluminum useful in the household are studied. Such topics as the action of alkalies on aluminum cooking utensils, the solvent action of some drinking waters on lead pipe, the tarnishing of silver in the presence of sulfids and the use of such action in making oxidized silver, the rusting of iron and the use of tin or zinc as a protective coating, the use of alloys and plated ware, and the methods of cleaning and polishing metals form the bulk of the work on metals.

The manufacture of the various kinds of glass and the discussion of the different kinds of pottery are topics which are given a very brief consideration.

The majority of the students find time to perform nearly all the experiments in the following list:

1. Preparation and properties of oxygen.
2. Preparation and properties of hydrogen.
3. Preparation and properties of hydrochloric acid (typical).
4. Preparation and properties of sodium and calcium hydroxides.
5. Preparation of salts. (Illustrating three methods.)
6. Presence of water in salts and its effects.
7. Quantitative determination of water in cryst, barium chloride.
8. Preparation of solutions; saturation; effect of temperature.
9. Destructive distillation of wood and coal. (Fuels and illuminants).
10. Properties of carbon; use as deodorizer and decolorizer.
11. Preparation and properties of carbon dioxid.
12. Distillation; coagulum purification of water.
13. Preparation and study of hard waters. Softening of hard waters.

14. Tests for simple impurities in drinking water.
15. Test for starch in several foods.
16. Test for glucose in several foods.
17. Test for proteins in several foods.
18. Test for fats and oils in several foods.
19. Milk; Babcock test; lactometer test; preparation of pasteurized milk; effect of rennin (junket tablets).
20. Preparation of baking powder. Tests of commercial powders.
21. Tests for preservatives: (a) formaldehyde in milk; (b) boric acid in wafers, ice-cream cones and milk; (c) salicylic acid or benzoic acid in catsup, jams, etc.; (d) sulfites in sausage and hamburg steak; (e) saccharin in canned corn.
22. Tests for adulterants. Selections are made from the following: (a) Starch and gelatine in ice-cream; (b) turmeric in mustard; (c) coal-tar colors in candy, jellies or butter; (d) chicory or cereals in coffee; (e) cottonseed oil in olive oil; (f) oleomargarine or process butter for butter; (g) copper salts in canned vegetables; (h) adulterants in vanilla or lemon extract; (i) adulterants in maple syrup; (j) glucose in candy; (k) manufactured vinegar for cider vinegar.
23. Test rancidity of butter or olive oil.
24. Test for alcohol in drugs; per cent of alcohol in drugs.
25. Tests for wood alcohol as a substitute for alcohol.
26. Extract caffein from coffee; thein from tea; test "Kaffee Hag."
27. Test headache powders for acetanilid.
28. Determine acidity of vinegar.
29. Determine purity of baking soda and cream of tartar.
30. Determine amount of soluble matter in tea.
31. Determine the amount of water oysters lose by drainage.
32. Examination of fibers; action of chemicals on linen, wool, silk and cotton.
33. Analysis of mixed fabrics.
34. Soap making. Free alkali in soap. Insoluble matter in soap.
35. Removal of stains: ink, grease, grass, coffee, tea, fruit, vaseline, mildew, iodin.
36. Preparation of aluminum hydroxid and its use with logwood and alizarin as a mordant.
37. Dyeing; direct dyes; basic dyes.
38. Study of solutions of resins in sodium hydroxid, linseed oil, alcohol and turpentine as varnishes.
39. Photography; blue prints.
40. Test paper, cloth, etc., for arsenic. (Gutzeit test.).

COLLEGE ENTRANCE EXAMINATION BOARD QUESTIONS IN CHEMISTRY.

By Henry Lester Gerry,

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Recently the writer has taken occasion to examine rather carefully the questions in chemistry set by the College Entrance Examination Board during the past ten years. This was done with the view of determining, if possible, the portions of elementary chemistry which the examiners seem to have considered most important or, at least, have asked most frequently. Such an analysis as this has been does not lend itself easily to verbal description; nevertheless, it is the purpose of this paper to try to point out some of the conclusions that may be drawn

with comparative surety relative to the general nature of the chemistry examinations of the period from 1911 to 1920.

This investigation used the "Definition of the Requirements in Chemistry" (College Entrance Examination Board Document, No. 93), and the examination questions of the past ten years as a basis for work. At the time the material was gathered, the fall Comprehensive Examination for 1920 had not been given, so those questions are not considered in this paper. In all, then, eighteen sets of examination question papers were scrutinized; ten of the Old Plan, the June Comprehensive Examinations for 1916 and 1920 and the June and September Comprehensive Examinations for 1917, 1918 and 1919. For each topic set down by the Board in its list of requirements the corresponding questions or parts of questions were noted in "A Collection of Representative Questions." Thus one question in an examination paper may appear as several items in the just mentioned collection. For example: In 1918 the following question was asked: "How would you prove, by chemical means, the presence (a) of carbon monoxide if mixed with sulphur dioxide? (b) of hydrogen if mixed with dry air (if the amount of hydrogen is too small to make the mixture explosive)? (c) of gold in copper? (d) of sulphuric acid in a solution of hydrochloric acid?" In the "Collection of Representative Questions" parts of this question appeared as four separate and distinct items under properties or recognition of carbon monoxide of hydrogen, of gold and of sulphuric acid; and perhaps might well have been placed in several other categories. Again, one part ("The water solution of a certain substance gives the following tests: The solution gives a deep-red color with ammonium or potassium thiocyanate [NH_4CNS or KCNS], and with barium chloride solution a white precipitate insoluble in hydrochloric acid. What may the dissolved substance be?") of a question asked in 1919 was twice entered, first under "recognition of ferric chloride" and again under "experiments." This method of analysis gave nearly 900 items from the eighteen examinations. Since not all questions on College Board Examinations have the same grading value, since the questions were dissected and part-questions entered in the material from which generalizations have been drawn, and since these part-questions often were entered more than once, the number of items under any one topic does not give the relative value in the minds of the examiners of that phase of the subject, but rather furnishes a

rough measure of the frequency of recurrence of that topic.

Anyone who has just thumbed over the pages of the question papers doubtless has been impressed with the almost certain annual recurrence of a series of partial equations. It is doubtful, however, if the casual observer has noticed the frequent recurrence of the equations representing a reaction in which barium sulphate is formed, copper reacts with nitric acid, hot concentrated sulphuric acid and copper interact and in which the products of heating concentrated nitric acid are indicated. In some form or other the barium sulphate reaction occurs no less than five times; the copper-nitric acid, three; the copper-sulphuric, twice; and the nitric acid, twice.

Every question paper within the period under examination, whether in Old Plan Examinations or in the Comprehensive Examinations in Chemistry, has had at least one problem in simple chemical arithmetic, with predominance held by problems concerning the volume of a gas derived from a known weight of one of the reacting substances. In each Old Plan Examinations since 1910 there has been an average of nearly five questions, or parts of questions, which required an arithmetical solution. In eight Comprehensive Examinations since 1915, about four stoichiometrical problems have averaged to appear in each paper. The relative frequency of the most common of these problems may be seen in Table I.

Table I.
Frequency of Most Common Numerical Problems in College Board Examinations, 1911-1920.

Type of Problem	Per cent of Frequency		
	Old Plan	Comprehensive	All
Law of Boyle	9.1	6.3	7.9
Law of Charles	9.1	12.5	10.5
Definite proportions	2.3	0.0	1.3
Multiple proportions	4.5	3.1	3.9
Percentage composition	18.2	25.0	21.2
Weights of substances concerned	20.4	18.7	19.7
Volume of a gas resulting from a reaction	36.4	34.4	35.5
Total	100.0	100.0	100.0

Almost every, if not every, examination question paper has dealt in some manner with the Electrolytic Dissociation Theory. It may have contained a question for the explanation of a simple case of electrolysis, of neutralization, of the reaction to litmus

of a dilute solution of copper sulphate or sodium carbonate, or a question regarding the use of electricity in electroplating, or any two or more of these divisions of the topic. Some one of the other theories or some common law of Chemistry is scarcely ever omitted from a question paper. Knowledge of the Laws of Boyle and Charles until recently have been tested by numerical problems. However, the June, 1920, Comprehensive Examination had a question designed to determine the understanding of the relationships between volume, temperature and pressure of a gas without asking for a statement of the laws or for a solution of a problem. The Law of Definite Proportions and the Theory of Valency have recurred intermittently. Of course, knowledge of the one is taken for granted when problems in percentage composition are solved; and familiarity with the other, in the writing of equations. Table II attempts to show the relative frequency of questions on some of the theoretic phases of the requirements.

TABLE II.

Frequency of Most Commonly Occurring Questions on Chemical Theory in College Board Examinations, 1911-1920.

Subject	Percent of Frequency		
	Old Plan	Comprehensive	All
Law of Boyle	6.2	6.5	6.3
Law of Charles	6.2	10.9	8.1
Law of Conservation of Mass	4.6	0.0	2.7
Law of Conservation of Energy	3.1	0.0	1.8
Law of Definite Proportions	9.2	0.0	5.4
Law of Multiple Proportions	4.6	4.4	4.5
Law of Gay-Lussac	3.1	4.4	3.6
Atomic Theory	7.7	8.7	8.2
Avagadro's Hypothesis	0.0	4.4	1.8
Electrolytic Dissociation Theory	26.2	41.2	32.4
Valence (aside from equations)	6.1	0.0	3.6
Energy Changes	4.6	6.5	5.4
Oxidation and Reduction	13.8	10.9	12.6
Catalysis	4.6	2.1	3.6
Total	100.0	100.0	100.0

It is unusual to find a question paper that does not in some way draw upon the laboratory experience of the student for the material of the answer. Questions of this nature have been those asking for the description of a piece of laboratory procedure, for the identification of specified substances, for the separation of two somewhat similar materials, or for means of distinguishing pairs of elements or compounds. This type of

question has made up 11.6% of the items of the Ordinary Examinations and 7.6% of the Comprehensive.

In the Old Plan Examination papers, questions requiring information about the common non-metallic elements have occurred nearly twice as frequently as those on the common

TABLE III.

Relative Frequency of Some of the More Common Topics Found in College Board Examinations, 1911-1920.

Topic	Percent of Frequency		
	Old Plan	Comprehensive	All
Common non-metals	17.7	25.4	20.3
Common metals	9.2	7.4	8.6
Common acids	17.2	28.6	21.1
Salts, oxides and hydroxides	39.5	21.3	33.3
Gases, not elements	16.4	17.3	16.7
Total	100.0	100.0	100.0

metallic elements and less than half as many times as those on metallic salts, oxides and hydroxides. Questions on non-elementary gases and on common acids each have occurred in the

TABLE IV.

Frequency of All Topics in College Board Examinations, 1911-1920.

Topic	Percent of Frequency		
	Old Plan	Comprehensive	All
Common non-metalic elements	8.0	9.0	8.4
Common metallic elements	4.2	2.6	3.6
Common acids	7.8	10.2	8.7
Salts, oxides and hydroxides	17.9	7.6	13.8
Gases (not elements)	7.5	6.1	6.9
Organic substances	2.5	2.6	2.5
Identification (laboratory)	11.6	7.6	10.0
Quantitative experiments	0.55	0.6	0.6
Equations	12.4	17.8	14.5
Reversible reactions	1.0	2.2	1.4
Laws and Theories	6.3	5.2	5.9
Electrolytic Dissociation Theory	3.1	5.2	3.9
Chemical arithmetic:			
Percentage composition	1.5	2.3	1.8
Weights of substances concerned	1.7	1.7	1.7
Volumes of gas from a reaction	3.0	3.2	3.1
Energy changes	0.55	0.9	0.7
Oxidation and reduction	1.7	1.5	1.7
Solutions	1.5	2.9	2.1
Others	7.2	10.8	8.7
Total	100.0	100.0	100.0

same series of papers nearly as frequently as those on the non-metallic elements. These five groups of questions have comprised quite 45% of the items in the ten Old Plan Examinations

since 1910. In the Comprehensive Examinations the relative proportions among these five items are somewhat different. Here, as in the other set of papers, questions on the common metals are least frequently asked, questions on non-elementary gases occur more than twice as frequently and from three to four times as frequently are found questions on common non-metallic elements, on common acids and on salts, oxides and hyrdoxides. This relationship is shown in Table III.

Table IV is a summary of the relative frequency of items found in both kinds of examination question papers from 1911 to 1920.

CHEMICAL NOMENCLATURE AND PRONUNCIATION.

By J. Norman Taylor,

Washington Preparatory School, Y. M. C. A., Washington, D. C.

The attention of educators is frequently called to the responsibility of secondary schools in the matter of preparing students for institutions of higher learning. Slow progress in college is attributed to lack of proper training in the student's preparatory life and not infrequently, failure in later life is ascribed to faults of secondary schools. A well-known research director, in writing of the lack of observation among chemists, states that "until a conscious effort is made in our primary education to meet this requirement, our advance in science will not be as speedy as it should."[1] A prominent educator implies this same lack of adequate preparation when he says, "And even if a freshman is somewhat dulled by his previous training, that seems scarcely a good reason for going on with the dulling process."[2] Not only as regards preparation in science is deficiency laid at the door of the secondary school, but the poor English employed by so many college graduates is likewise charged to the same source. "A university graduate's inaptitude in the art of writing may be due, however, not to faults in his university course; more likely it is due in part to inefficient methods employed in the schools in which he obtained his earlier training in English."[3]

Granting the fact that the lower schools are responsible for deficiencies which handicap the individual later on, it will be agreed that in secondary schools, method is of great importance. If we are to utilize the scientific method in teaching science, then it

[1]Rose, Robert E., "The Education of the Research Chemist": Jour. Ind. and Eng. Chem., vol. 12, p. 948, 1920.
[2]MacArthur, C. G., "The Scientific Teaching of Science": Science, new ser., vol. LII, p. 350, 1920.
[3]Wood, George McLane, "Suggestions to Authors": U. S. Geological Survey, p. 52, 1916.

follows that in English-speaking countries good English, both with regard to spelling and pronunciation, should be used to convey our thoughts regarding science.

Although perhaps not a vital matter, it nevertheless appears to the writer that in teaching chemistry, the nomenclature used in secondary schools, so far as chemical words and terms are concerned, should agree with that employed in the higher institutions of learning. Dean Wilbur in speaking of good use in language, with particular reference to national use, says, "There is a law of national use that restricts us to those words that are in good use throughout the land. . . . A word that is not in good current use throughout the land is inefficient. Misunderstanding and perplexity and vagueness follow in the track of such a word."[4] In instances where chemical facts have been conveyed to the preparatory school student through the medium of corrupt English, confusion is bound to follow when his teacher in college uses pure English. And a change from pure English to corrupt forms is equally confusing. Certainly, there should not be any confusion in this regard and greater uniformity should obtain both as to terminology and pronunciation.

If it is correct to spell the word phosphorous with "ph," why should not the same principle in orthography be followed when writing the word sulphur? Good English would require that the names of the members of the halogen group be spelled with the final "e," as "fluorine," "chlorine," "bromine," and "iodine," and that they be pronounced as they are spelled and not as though the termination were "in." Likewise good English demands that the names of the chemical compounds known as the halides be spelled with the final "e"[5] and that they be pronounced as they are spelled. The names of analogous compounds should terminate in "ide," as for example: carbide, oxide, sulphide, phosphide, nitride, selenide. The names of these compounds should not be pronounced as though they terminated in "id." Acids, bases, and salts should be written and pronounced with a proper regard for good English.[6] In naming salts, the negative terminations should be "ate" and "ite" and the names should be

[4]Wilbur, William Allen, "English Rhetoric": Judd and Detweiler, Inc., Washington, 1917, p. 260.

[5]Consult "Inorganic Nomenclature" in the introduction to a "German-English Dictionary for Chemists," by Austin M. Patterson, published by John Wiley and Sons, Inc., New York, 1917.

[6]Examples of good chemical nomenclature are to be found in "A Dictionary of Chemical Terms" by James F. Couch, published by D. VanNostrand Co., New York, 1920.

[7]Crane, E. J., "Chemical Nomenclature": Jour. Ind. and Eng. Chem., Vol. 11, p. 72, 1919.

pronounced as they are spelled and not as though they terminated in "at" and "it."

We must conclude with Dr. Crane that "good English in chemical literature, particularly in naming compounds, needs cultivation."[7] Its choice is based on a proper regard for derivation and good usage, and this latter desideratum requires the use of pure English by English speaking people, both in writing and pronunciation. Elimination of un-English terminology in chemical literature may be brought about by following Dean Wilbur's injunction: "Cultivate your own heritage. Cast away your mannerisms and discard your provincialisms, but cherish as a trust your own style and express it in our common language for the common good." Let those who teach chemistry in our schools and colleges observe good usage and adhere strictly to real English rather than to individual preferences.

FORD EDUCATIONAL LIBRARY.

Ford Motion Picture Laboratory is engaged in the production of an educational film library, to be known as the "Ford Educational Library," that will provide for the public and private schools and colleges of every nation in the civilized world films distinctly for class-room use in the way that will make them of greatest value and easiest to obtain. By placing at the service of every educational institution a product based on the principles of sound pedagogics and edited by leading professors of the universities of the United States and competent authorities in screen instruction in the schools Henry Ford not only will supply school needs but will fulfill the ambitions of the pioneer professors and instructors, until now seriously handicapped in their efforts to secure films designed by teachers for teachers' use in class-room work. On September 1, the first issue of this library will be available to every school in the United States. The subjects will be specially prepared for use in any class-room by members of the scholastic profession who are experts in their particular line and the units as arranged will be distributed under a plan that will fully meet all conditions in each school, whether the schools be large or small. The library will further offer to every university and college in the United States facilities for the production by their own professors of films for world-wide school use in any quantities that may be necessary to meet the constantly increasing demand.

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PROBLEM DEPARTMENT.

Conducted by J. A. Nyberg,
Hyde Park High School, Chicago

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and solve problems here proposed. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The Editor of the department desires to serve its readers by making it interesting and helpful to them. If you have any suggestion to make, mail it to him. Address all communications to J. A. Nyberg, 1044 E. Marquette Road, Chicago.

SOLUTION OF PROBLEMS.

661. *Proposed by Jas. H. Packham, Collegiate Institute, Owen Sound.*

Given an $\angle ABC$, a point Q on BC, and a point P between the sides of the angle. Construct an isosceles triangle, having its vertex on AB, its base on BC, one extremity of the base at Q, and the side opposite Q passing through P.

I. *Solution by Norman Anning, Ann Arbor, Mich.*

Let BA have the equation: $y = kx$;
BC the equation: $y = o$;
Q the coordinates: (a, o); and
P the coordinates: (b, c). Let S be the other extremity of the base of the isosceles triangle, and let it have the coordinates: (s, o) where s remains to be determined.

The vertex, R, of the isosceles triangle lies upon the lines $2x = a+s$, $y = kx$, and, consequently, has the coordinates

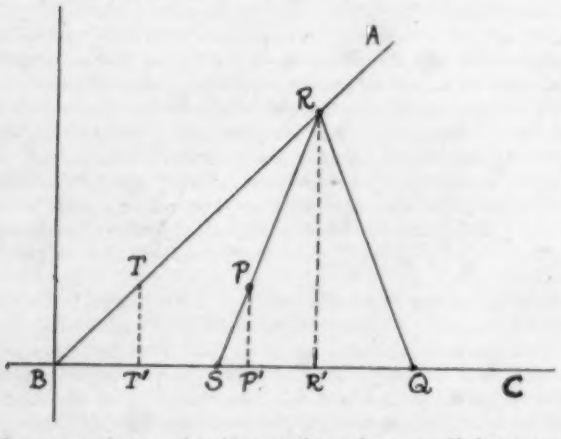
$$[(a+s)/2,\ k(a+s)/2].$$

Now P lies upon the line RS, hence

$$\begin{vmatrix} s, & o, & 1 \\ b, & c, & 1 \\ a^2+s, & k(a+s), & 2 \end{vmatrix} = 0.$$

or

$$s^2(k)+s(ak-bk-c)-abk+ac = 0.$$



Since s is a root of a quadratic equation whose coefficients are functions of the known quantities, a, b, c, k, its value can be constructed, step by step, with straight-edge and compasses.

Similarly solved by A. Pelletier, Montreal, Can.

II. *Comment by the Editor.*

After discovering the solution by analytic geometry as above, it is

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possible to translate the analysis into the language of elementary geometry because the problem involves only lines. Thus:

Instead of saying the equation of BA is $y = kx$, we will select an arbitrary length BT′ for unity. Draw T′T, PP′, RR′ ⊥ BC. Measured with BT′ as a unit, let the lengths of the various lines be: T′T = k, P′P = c, BP′ = b, BS = s, BQ = a. We calculate BR′ = $(a+s)/2$ since R′ is the midpoint of segment SQ. From the similar triangles BT′T and BR′R, we calculate R′R = $k(a+s)/2$. Then from the similar triangles SP′P and SR′R we derive the proportion SP′/P′P = SR′/R′R, which reduces to

$(b-s)/c = (a-s)/k(a+s)$ or $s^2k+s(ak-bk-c)-abk+ac = 0$.

Here s is the unknown which is to be determined.

The reader who is unfamiliar with such a method of analysis may wonder why we are permitted to choose *any* length BT′ for unity. This question would be answered if we try to carry out the construction. For example, we must find the products ak, bk, etc. The fourth proportion to BT′, a, k, would be ak; the fourth proportion to BT′, b, k, would be bk. And changing the length BT′, would also change k, but leave ak or bk unchanged. As a matter of fact bk is merely the length of the perpendicular to BC from P′ to its intersection with BA, and ak is the length of the perpendicular to BC from Q to its intersection with BA. These lengths are independent of any choice of BT′.

662. *Proposed by J. L. Riley, Stephenville, Texas.*

If a, b, c, d are the sides, and $\triangle$ the area, of a quadrilateral inscribed in a circle of radius R, prove that

$$16R^2\triangle^2 = (ab+cd)(bc+da)(ca+db).$$

Solution by J. H. Packham, Owen Sound, Can.

Let A, B, C, D be the vertices of the quadrilateral, AB = a, BC = b, CD = c, DA = d, AC = e, BD = f. Then

$2\triangle = ab\sin B+cd\sin D = (ab+cd)\sin B$

since B and D are supplementary angles. Similarly,

$2\triangle = (ad+bc)\sin A$.

Drawing a diameter from D, we see that $\sin A = BD/2R$; and similarly, drawing a diameter from C, $\sin B = AC/2R$. But since the quadrilateral is inscribed in a circle, $ef = ac+bd$ (Ptolemy's Theorem). By substitution and multiplication we derive the desired equation.

Also solved by N. Anning, A. Pelletier, W. R. Warne.

663. *Proposed by A. Pelletier, Montreal, Canada.*

Prove that the product of four consecutive numbers can not be a perfect square.

Solution by L. E. Mensenkamp, Freeport, Illinois.

If we denote the four consecutive numbers by n, $n+1$, $n+2$, and $n+3$, we have the identity

$$n(n+1)(n+2)(n+3) = (n^2+3n)(n^2+3n+2) \qquad (1)$$

where the first member of the right hand side is obtained by multiplying the first and last factors of the left hand side, and the second factor on the right side is the product of the two intermediate factors of the left side.

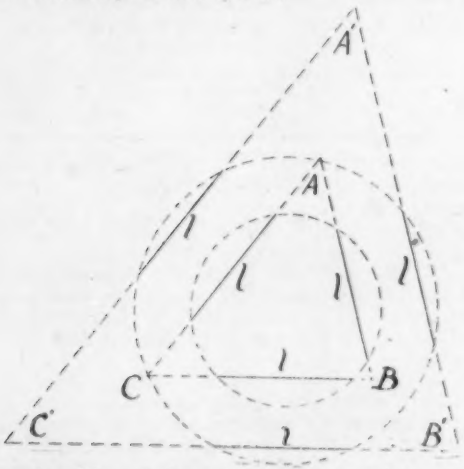
If we set $k = n^2+3n+1$, we see from the right side of (1) that our given product becomes $(k-1)(k+1) = k^2-1$. Hence the product of our four consecutive numbers is always equal to the square of an integer diminished by one, and therefore can not itself be the square of an integer.

Also solved by N. Anning, J. H. Packham, W. R. Warne, and the Proposer.

664. *Proposed by N. P. Pandya, Amreli, Kathiawad, India.*

Three equal chords (length l) of a circle form, when produced both ways, a triangle ABC. Express the sides of the triangle in terms of its angles and l. Hence find under what circumstances the sides would be in geometrical progression.

Remark by A Pelletier, Montreal, Can.



It seems that the sides of the triangle can not be expressed in terms of its angles and l. The figure shows that two triangles may have the same angles and l, and still have their corresponding sides unequal.

665. *Proposed by W. R. Warne, State College, Pa.*

Solve $\cos(ax) \cdot \cos(bx) = \cos(a+c)x \cdot \cos(b+c)x$.

Solution by J. F. Stecker, Pennsylvania State College, Pa.

Since $2\cos(ax)\cos(bx) = 2\cos[(a+c)x]\cos[(b+c)x]$,

$\cos(a+b)x+\cos(a-b)x = \cos(a+b+2c)x+\cos(a-b)x$,

or, $\cos(a+b)x = \cos(a+b+2c)x$,

$(a+b)x = 2k\pi \pm (a+b+2c)x$

where k is any integer, positive, negative or zero.

Solving for x, $x = k\pi/c$, $k\pi/(a+b+c)$.

Also solved by N. Anning, J. H. Packham, A. Pelletier, and the Proposer.

PROBLEMS FOR SOLUTION.

676. *Proposed by W. R. Warne, Pennsylvania State College, Pa.*

A quadrilateral ABCD is such a one that a circle can be inscribed in it and another circle circumscribed about it. Prove that

$$\tan^2 A/2 = bc/ad.$$

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677. *Selected.*

Prove the following theorem due to Ceva (Milan, 1678):

Lines drawn through the vertices of a triangle, and passing through a common point, determine upon the sides six segments, such that the product of three non-consecutive segments is equal to the product of the three other segments.

678. *Proposed by A. Pelletier, Ecole Polytechnique, Montreal, Can.*

Prove that the square of an integer is never of the form $12n+5$.

679. *Proposed by several contributors during the past year.*

At what time past h o'clock is the minute hand m minutes ahead of the hour hand, assuming naturally that both hands move at a uniform rate and not by jerks?

680. *For undergraduates. See announcement in October issue. Proposed by Norman Anning, Ann Arbor, Mich.*

If it requires 11 "rounds" of the binder to cut one-half of a rectangular wheat field and 14 more to cut the remainder, find the ratio of the length of the field to its width. All swaths are full width.

The department frequently receives problems concerning the value of which it is undecided, either because of the difficulties involved or because the interest may be limited. Three are presented below. The editor invites an expression of opinion. Solutions if received will be presented.

A. *Proposed by R. T. McGregor, Elk Grove, Cal.*

If on an average of one vessel in every ten is wrecked, find the chance that out of five vessels expected at least four will arrive safely.

B. *Proposed by J. H. Packham, Owen Sound, Can.*

The arc of a circle is one mile long and the chord of the arc is six inches less. Find the radius of the circle.

C. *Proposed by Burrell Morgan, Panther, W. Va.*

By arithmetic solve: Over what area can an aviator gaze when up 2,000 feet above the open ocean?

SCIENCE QUESTIONS.

Conducted by Franklin T. Jones,

The Warner & Swasey Company, Cleveland, Ohio.

Readers are invited to propose questions for solution—scientific or pedagogical—and to answer questions proposed by others or by themselves Kindly address all communications to Franklin T Jones, 10109 Wilbur Ave., S E., Cleveland, Ohio

Please send examination papers on any subject or from any source to the Editor of this department. *He will reciprocate by sending you such collections of questions as may interest you and be at his disposal.* **Ask for the examinations you would especially like to get.**

FOREIGN EXAMINATIONS.

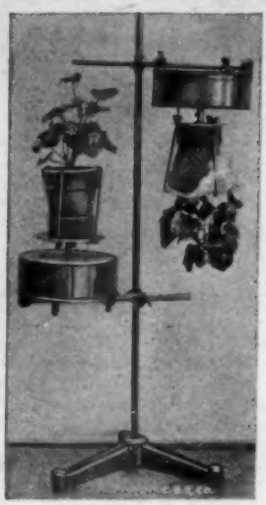
The editor of this department desires to obtain examinations in NATURAL SCIENCE (as well as other subjects) from schools in France, Belgium, Italy, Spain, Denmark, Sweden, Norway and Finland Any reader of SCHOOL SCIENCE AND MATHEMATICS in these countries will confer a great favor upon the editor by writing to him upon this subject.

QUESTIONS AND PROBLEMS FOR SOLUTION.

In the June, 1920, number of SCHOOL SCIENCE AND MATHEMATICS, page 556, there was published an examination in *Dynamics* from the Scottish Universities Entrance Board. You are requested to give these problems to your classes in physics, or to individuals, and send in their solutions, right or wrong.

There follows below two examination papers, one given in March, 1919, by the Scottish Universities Entrance Examination Board and one given in June, 1920, by the College Entrance Examination Board. Obtain solutions of the problems numbered:

349, *350*, *351*, *352*, *353*, and *354*.



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SCOTTISH UNIVERSITIES ENTRANCE EXAMINATIONS.

DYNAMICS.

Wednesday, 19th March, 1919, 3 to 6 p. m.

A Candidate may obtain FULL *marks by doing about two-thirds of this Paper.*

Marks will not be awarded to answers where the work is not shown.

N. B.—*Candidates must write on their books the number of the table at which they sit.*

1. Define Uniform Velocity, and explain what is meant by Relative Velocity.

One ship sails west at the rate of 20 miles per hour from a point 10 miles due south of another ship which is sailing due south at the rate of 15 miles per hour: find the relative velocity of the first ship with respect to the second.

349. The measure of an acceleration when the units of space and time are a foot and a second is 3. What would be the measure of the same acceleration when the units are a yard and a minute?

A body starting from rest, and moving with uniform acceleration, describes 16 1/4 ft. in the seventh second of its motion: find the acceleration.

3. Show how a force may be completely specified by means of a finite straight line.

Two forces whose magnitudes are 30 and 40 respectively act at right angles. Find their resultant force. Resolve this resultant force into two components, one of which is a force of magnitude 60 at right angles to it.

4. Find the resultant of two unequal parallel forces acting on a body in opposite directions.

350. The arms of a balance are unequal in length. If a mass appears to weigh 25 grammes when placed in one scale pan, and 24 grammes when placed in the other pan, find its real weight, if the weights of the arms and the scale pans may be neglected.

If the arms are equal but the scale pans are of different weights, and the mass seems to weigh 25 grammes and 24 grammes, in the respective pans, find its real weight.

5. Find the Centre of Gravity of a triangular lamina.

From a corner of a triangular plate is cut off a fourth part of its area by a straight line parallel to its base. Find the position of the Centre of Gravity of the remainder.

351. Three weights of 1, 2, and 3 lbs. respectively are placed at the angular points A, B, C of an equilateral triangle. Find the perpendicular distance of their common Centre of Gravity from the side BC when the side of the triangle is 2 ft.

6. Define Work; and Kinetic and Potential Energy.

When a body moves in a straight line under the action of a uniform force, show that the change of kinetic energy per unit of space is equal to the acting force.

Find the work done in dragging a weight of 100 lbs. through 100 ft. up a rough inclined plane inclined at 30° to the horizon, assuming the coefficient of friction to be $1/\sqrt{3}$.

7. Prove that the algebraic sum of the moments of two parallel forces about any point in their plane is equal to the moment of their resultant about the same point.

352. A uniform bar, 3 ft. long and weighing 5 lbs., can turn freely about a point 11 inches from one end, and from that end a weight of 15 lbs. is suspended. From what point of the bar must a weight of 30 lbs. be suspended so as to preserve equilibrium?

8. (*a*) Make a drawing of a system of three pulleys in which the strings are attached to the weight; and find the relation between the power and the weight.

353. (*b*) If each of the three pulleys weighs 2 pounds, find the weight raised if the power applied be 16 pounds weight.

9. Explain the meaning of the term *Density* of a substance.

(*a*) Explain how you would find the Sp. Gravity of lead.

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354. (*b*) The Sp. Gr. of salt water being 1.04, find how much fresh water must be added to a pint of it to reduce its specific gravity to 1.015.

10. A U-tube contains mercury in its lower portion.

Water is poured into one limb to a depth of 9 inches, and alcohol into the other to a depth of 10 inches, and the surfaces of the mercury in the two limbs are then in the same horizontal plane;

What change in the levels of the mercury in the tube takes place when two inches of alcohol are taken away?

(Sp. Gr. of mercury 13.6.)

11. How is Boyle's Law usually verified in the laboratory?

A cylindrical diving-bell 8 ft. high is let down into water until its top is 20 ft. below the surface of the water. To what height will the water rise in the bell, the water barometer standing at 33 feet?

PHYSICS.

Friday, June 25, 1920, 2 p. m. Two hours.

Answer ten questions as indicated below. No extra credit will be given for more than ten questions.

Indicate clearly your reasoning in each problem and state the units in which each answer is expressed.

Number and letter each answer to correspond with the question selected.

GROUP I

(Omit one question from this group.)

1. (*a*) Distinguish between mass and weight. (*b*) Could the fact that the weight of a body changes if it is taken from the equatorial to the polar region of the earth be shown by either a spring balance or a beam balance? Explain.

2. A body having a volume of 100 cubic centimeters and a density of 2.5 is fastened to a block of wood having a volume of 200 cubic centimeters and a density of 0.5. (*a*) What will the combination weigh when immersed in water? (*b*) What will the combination weigh when immersed in oil of density 0.9?

3. (*a*) Represent by a diagram a system of pulleys consisting of a double fixed block and a single movable block. (*b*) If the efficiency of the above system is 70 per cent, how great a weight can be lifted by a force of 30 pounds applied to the free end of the rope?

4. What horse power is required to run an automobile on a level road at the rate of 30 miles per hour if the forces of friction amount to 125 pounds?

GROUP II

(Omit one question from this group.)

5. (*a*) How are sounds produced and how are they transmitted to the ear? (*b*) How does the intensity of sound vary with change of distance from the source?

6. (*a*) If the lowest tone which the ear can recognize has a frequency of 16 vibrations per second what is the length of the longest wave the ear perceives in air at a temperature of 0°C.? (*b*) What effect, if any, does change in temperature produce in the velocity of sound in air?

GROUP III

(Omit one question from this group.)

7. (*a*) Define dew point. (*b*) What is meant by the relative humidity of the air? (*c*) How may the relative humidity of the air be experimentally determined?

8. If gas costing $1.00 per 1,000 cubic feet furnishes 600 B. T. U. of heat per cubic foot of gas burned, how much would it cost to raise from 62°F. to 212°F. one quart (2 pounds) of water by means of a burner and kettle having a combined efficiency of 50 per cent?

9. (*a*) Describe in detail an experimental method for determining the specific heat of a substance. (*b*) Explain how a numerical result may be secured from the data obtained.

GROUP IV

(Omit one question from this group.)

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10. In a darkened room a spectrum of sunlight is thrown on a screen. A bouquet of red, yellow, and blue flowers with green foliage is placed in the red end of the spectrum and gradually moved toward the violet end. State and explain what would be observed.

11. (*a*) Describe the construction and explain the operation of the so-called "pin-hole" camera. (*b*) If such a camera is 8 inches long and the image of a building 50 feet high appears as an image 3 inches high on the plate how far away is the building?

12. (*a*) Represent by a diagram the path of the rays of light through the lenses of an astronomical telescope. (*b*) A telescope has an objective whose focal length is 30 feet and an eye-piece whose focal length is 1 inch. What is the magnifying power of the telescope?

GROUP V

(*Omit one question from this group.*)

13. (*a*) Given one battery, one bell, two push buttons, and a quantity of wire, represent by a simple diagram a scheme for wiring a house so that the bell may be rung from either the front door or the back door. (*b*) Why is it advantageous to use a high voltage for the transmission of electric energy over long distances? (*c*) Why are alternating currents used for long distance electrical transmission?

14. A 17-candle-power carbon filament lamp takes 0.6 ampere at 110 volts. A 260-candle-power gas filled tungsten filament lamp takes 1.85 amperes at 110 volts. Compare the efficiencies of the two lamps.

15. The poles of a storage cell having an electromotive force of 2 volts and an internal resistance of 0.1 ohm are connected by two wires in parallel whose resistances are 12 ohms and 4 ohms respectively. (*a*) What current flows in each wire? (*b*) What current flows through the cell?

SOLUTIONS AND ANSWERS.

331. A Colt automatic bullet has a brass rounded point with lead back. If shot into the air, which end of such a bullet comes down first? Why? *Anonymous solution "from a soldier."*

Do you agree with him?

Problem on brass pointed bullet fired from Colt Automatic. Brass, 8.4 sp. gr. Lead, 11.37 sp. gr.

Bullets usually travel in the position such that the lighter or more sharply pointed part goes ahead and the heavier blunt part to the rear. Since the brass point is lighter than the lead at the rear, and also harder, it is natural to suppose that the brass rounded point travels ahead and comes down first. Further, it is unlikely that bullets would be so designed as to cause them to whirl end over end, as this would decrease their travel as well as their force. This whirling would result if the blunt heavy part were to go ahead.

335. *Test V, Physics, Society for the Promotion of Engineering Education,* (SCHOOL SCIENCE AND MATHEMATICS, January, 1920, page 177.)

Answers were *few.*

A professor in an engineering college had *all right.* A university graduate who teaches in a very prominent school had *seven* wrong and *one* not answered. A high school teacher of physics in a small town had *four* wrong.

339. *Test VI, Technical Information, Soc. Prom. Eng. Ed.,* SCHOOL (SCIENCE AND MATHEMATICS, April, 1920, page 369.)

Try this with any of your classes and send in the result.

The following answer was received which is published in full:

Dear Sir: I tackled those Carnegie Institute questions Test VI, published in the April SCHOOL SCIENCE AND MATHEMATICS and could answer all but five or six. As I have taught physics forty years and manual training more or less I was a little ashamed that I failed on any. I wonder how a lot of the other fellows did. Very truly yours,

A. A. UPHAM, Whitewater, Wis.

H. M. Snethen also sent in a report.

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BOOK REVIEW.

Lighting from Concealed Sources, by J. L. Stair, Natural X-Ray Reflector Company, Chicago, Illinois. 246 Pages. 20x25 1-2 cm. Cloth. 1919.

This firm deserves a great deal of credit for perfecting an indirect method of illuminating, not only private homes, but public halls as well. As applied to school buildings, this method of illumination cannot help but increase the efficiency of the schools, enabling the pupils on dark days to receive the right kind of light and at the same time, remove the intense glare from direct illumination. This unquestionably will result in fewer headaches and a better concentration of pupils mind on the working question. The book is profusely illustrated, giving many views of interiors of different public buildings, stores, schools and private homes. There are 480 illustrations and drawings, showing the way in which the light is distributed.

It is a work which architects of public buildings and people who are contemplating not only outdoor lighting, but the interior lighting of new and old homes should secure and carefully study. C. H. S.

ARTICLES IN CURRENT PERIODICALS.

American Botanist, for August; *Joliet, Ill.*; $1.50 *per year*, 40 *cents a copy:* "The Desert Trumpet Flower," Willard N. Clute; "Notes on Comparative Regeneration in Elodea and Ceratophyllum," N. M. Grier; "Wildflowers of the Oregon Coast," R. V. Bradshaw; "Plant Names and Their Meanings," Willard N. Clute.

American Journal of Botany, for October; *Brooklyn Botanic Garden, Brooklyn, N. Y.*; $6.00 *per year*, 75 *cents a copy:* "Absorption of Moisture by Gelatin in a Saturated Atmosphere," Charles A. Shull and S. P. Shull; "Slow and Rapid Growth," H. S. Reed; "Cytology and Systematic Position of Porphyridium Cruentum Naegeli," Ivey F. Lewis and Conway Zirkle; "Somatic Chromosomes in Tradescantia," Lester W. Sharp.

Geographical Review, for November; 156th *Street and Broadway, N. Y.*; $5.00 *per year*, 50 *cents a copy:* "The Port of Paris," by Albert Demangeon (2 maps, 9 photos); "On Eskimo Stone Rows in Greenland Formerly Supposed to be of Norse Origin," by Morten P. Porsild (1 map, 2 diagrams, 4 photos); "Airplanes and Geography," Willis T. Lee (2 maps, 9 photos); "A Method of Aerophotographic Mapping," Fred H. Moffit (3 diagrams, 7 photos); "A New Series of Sunshine Maps of the United States," Robert DeC. Ward (1 map).

Physical Review, for October; *Ithaca, N. Y.*; $7.00 *per year*, 75 *cents a copy:* "The Tones from Bells," Arthur Taber Jones; "The Valency of Photo-electrons and the Photo-electric Properties of Some Insulators," M. J. Kelly; "The Detecting Efficiency of the Electron Tube Amplifier," E. O. Hulbert and G. Breit; "The Minimum Arcing Voltage in Helium," K. T. Compton, E. G. Lillym, P. S. Olmstead; "Electrification by Impact," Harold P. Richards; "A New Design of Precision X-Ray Spectrometer," C. D. Cooksey; "The Performance of Conical Horns." G. W. Stewart; "The High Frequency Spectra of Lead Isotopes," C. D. Cooksey and D. Cooksey; "On the Variation of the Factor h in the Equation $\frac{1}{2}mv^2 = hv$," Fernando Sanford; "A Study of Residual Ionization in a Gas with Reference to Temperature Effects," C. H. Kunsman.

Popular Astronomy, for November; *Northfield, Minn.*; $5.00 *per year*, 50 *cents a copy:* "Dedication of Observatory at Case School of Applied Science," with Plate XXII, K. O. Thompson; "Definition and Resolution," William H. Pickering; "Twenty-Fourth Meeting of the American Astronomical Society," with Plate XXIII, Continued; "Occultations of Stars by the Moon," Frederick R. Honey.

School Review, for November; *The University of Chicago Press;* $2.50 *per year*, 30 *cents a copy:* "Americanization in the Thornton Township High School," Lewis W. Smith; "The Peculiar Functions of the Junior High School: Their Relative Importance," Leonard V. Koos; "Faculty

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Organization in the Theodore Roosevelt High School," B. C. Richardson; "The Dalton Plan," E. D. Jackman; "Harlan's American History Test in the New Trier Township Schools," G. L. Griffith.

Scientific Monthly, for November; *Garrison, N. Y.*; $5.00 *per year*, 50 *cents a copy*:"The Role of Physiolography in Military Operations," Kirk Bryan; "Growth of New York and Suburbs Since 1790," James L. Bahret; "Education and Learning in America," Arthur Webster; "The British Association for the Advancement of Science:" "Fossils and Life," Dr. F. A. Bather; "Heredity," Miss E. R. Saunders; "The Supply of Oxygen to the Tissues," J. R. Barcroft; "Intensive Cultivation," Frederick Keeble; "The Problems of Anthropology," Karl Pearson; "The Individual Child and Methods of Teaching," Sir Robert Blair; "Evolution's Most Romantic Moment," Roy L. Moodie; "An Ancient Moonfish," Dr. David Starr Jordan.

ASSAILS AMERICAN TEACHING METHODS.

Defects in the American schools were sharply criticized in a recent paper "The Education of the Research Chemist," read by Dr. Robert E. Rose, a research chemist connected with the E. I. du Pont de Nemours Company of Wilmington, Del., before the Dye Division of the American Chemical Society at the University of Chicago.

"The education of the men," said Dr. Rose, "who are to lead the dye industry to future successes is a matter of vital interest to us. The subject is equally of interest, in its general aspects, to all who teach and to all who are concerned with commercial enterprises founded on the technical application of the results obtained by research.

"The dye industry in this country was established with the aid of research men who were not trained for this special line of work; they were men of general training and their adaptability to their new duties throws a very interesting light on the educational system of which they are the products.

"They were very successful, let that be emphasized, but at the same time let us study such faults as were apparent in order that we may learn how to improve the training given in our schools.

"The worst failings were a tendency to overlook trifling indications such as slight differences in color or structure or smell, and a disregard for the necessity for reasoning precisely and understanding clearly before doing any experiments, that is, there was a lack of exact observation coupled with rather vague reasoning.

"Of course, this was not true of the maturer men, but rather of those fresh from the training of the university. The causes of these faults lie very far back in our methods of teaching. Research is nothing strange; it is simply the use of the results of well trained powers of observation by a mind capable of clear reasoning. The child who by the careful examination of a mechanism, learns how it works, is applying the methods of research. The chemist examines the substances of which the world is composed, finds how they are put together and learns how to make new ones. The essential of this kind of work is well trained senses, and the development of the senses is very largely determined during the years of early childhood. It is for this reason that we may say that the research man is made or marred during childhood and adolescence. However, we do not make a great effort to train the senses during childhood; instead we put a premium on developing the memory and formal methods of reasoning. Later in high school and university we continue to give the student too many second hand facts instead of making him observe for himself. We teach him to reverence the opinion of others rather than his

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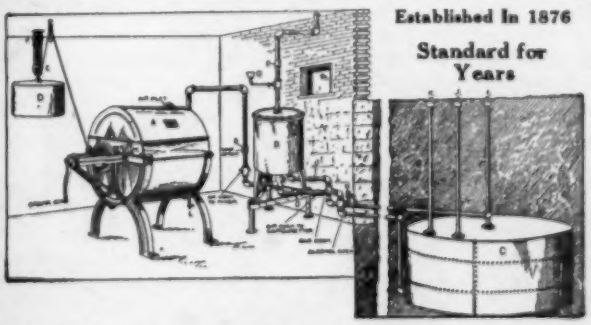

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own and thereby kill that healthy skepticism which is the essence of research.

"The courses in chemistry are apt to call for an exercise of memory rather than of reasoning, though they are better in this country than in any other. The future dye chemist is called upon to learn many formulas by eye without being given a good understanding of their real meaning. Finally, the research work in our universities is hampered by the routine duties placed on the teaching staff and therefore we find very few institutions which can be regarded as great schools of research where many men learn from each other the enthusiasm of the true investigator. We are too apt to regard research as fulfilling, in part, the requirements for the degree of Doctor of Philosophy, instead of adding to the sum of human knowledge.

"The remedies are easy to state but hard to apply. The teaching of observation, the training of the senses can be done properly only by really efficient grade school teachers, with the cooperation of parents. Some day we shall recognize the fact that the school teacher is of more importance to our supply of research men than is the college professor. Some day we shall admit that schooling, though intangible, is worth more than railroads, mills, and all other material things save only food and that it is worth paying for. When we shall have better dye chemists.

"In the high schools and universities, we need a higher average of excellence in the teaching staffs. There are very many extremely able men, but there are also many unambitious, rote teachers who teach because they find it easier to do that than anything else, men who are never up-to-date. We need better text books, especially of organic chemistry—we have nothing in this line which is in keeping with the modern development of applied organic chemistry. I do not mean a technology, but a text giving due emphasis to the applications made of knowledge expressed in the facts and theories of the class room.

"To foster pure research we should have institutions set aside for research, institutions to develop, as the years pass, into great schools wherein the advance of the science will be aided by all the resources of the nation.

"The teaching of research is a subject of interest to all, because the measure of the success of a nation is the quality and number of her trained specialists. It is of special interest to us because the industry to which we are devoted needs, more than any other, a great number of capable research men. It is for that reason I address this paper to the Dye Section of the American Chemical Society."

AMERICAN RED CROSS—WHY THE COLLEGES SHOULD SUPPORT THE RED CROSS.

When America went into the war there was an immediate rush of college men to take their places on the firing line. By fall 150 institutions reported that 13,520 students were in the army or navy, and 1,650 had gone into non-military activities. Whereas the undergraduates for the most part went into active service, the alumni, or those of them who for one reason or another were unfitted for army or navy, went into the service of the relief organizations.

Hundreds of college men and women went into the Red Cross. In fact, this organization was largely made up of college personnel. They went into it because it was constructive, because it gave them a chance to apply practically those ideals which are the ideals of America, and which the training they have received in colleges and universities has taught them to honor and cherish.

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And then the war ended. A good many people thought that the Red Cross would end too. But disease and suffering did not end with the war. Health and good citizenship are as important today as they were two years ago. And so the Red Cross work goes on. It still stands for the ideals of America—the ideals which it is the privilege and the duty of every university man and woman to further and cherish.

It is the duty and the privilege, therefore, of every college student to stand back of the Red Cross, to aid it in every way possible in its after-war campaign for a healthier and happier America. The Annual Red Cross Roll Call will be held November 11-25. Ten million Americans joined or renewed their memberships last year. The Red Cross counts on its college friends to join, again, this year.

AIMS OF MODERN GEOGRAPHY TEACHERS.

By E. E. Lockey,

State Normal School, Wayne, Nebraska.

If we are to play our parts well as good citizens in the new social and economic order into which we are moving, it is quite necessary that we become thoroughly conversant with the life and problems of the peoples with whom we are associated. The world is becoming smaller every day. We hear from neighboring towns about once a week, but from France, Russia, and China every day. What happens in Europe this morning we may have in this morning's paper. Since we can keep ourselves informed concerning important affairs in Europe or South America as easily as we can keep up on the community gossip, it seems that the whole world has really become one large neighborhood of interesting and interdependent folks. Society will expect the educated man or woman of the future to understand well the social and economic ties that bind the peoples of the world together into one large unity. If our children are to develop into worthy leaders for the future, it is our duty to provide ample opportunity for them to study these problems. What can our schools offer children that will satisfy this pressing need? The answer is evidently more and better geography. The trend of modern geography is well shown in the following statement of aims.

1. Geography should seek to create in the children an abiding interest in how the people of different countries live, their important industries, their fine achievements, their pleasures, their leisure time activities, and the reciprocal duties and responsibilities that exist between them and us.

2. It should give pupils a mastery of geographic facts and principles so they will be able to explain the operation of the interacting phenomena noted in connection with the developing of important industries, the location and growth of leading cities, and the interdependence of the peoples in different parts of the world.

3. It should produce a social orientation in the lives of the pupils such as will lead them to a sympathetic study and understanding of peoples and races other than their own.

4. It should determine for the pupils whether or not a people are using wisely the resources nature has given them, how they may improve their opportunities, and what we may do to assist them.

5. It should give such a thorough training in the use of the tools of the subject, namely, maps, texts, reference books, government bulletins, etc., that the pupils may become independent workers in the solution of geographic problems.

Training in this kind of geography will furnish vital material with which to develop an intelligent citizenship that will find equitable adjust-

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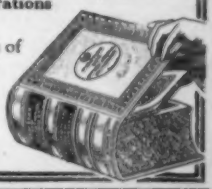

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ment for the intricate difficulties that are being forced upon us by the world's becoming smaller every day, and by our neighbors crowding us from every side.

The reason that geography training has not produced better results in terms of the aims here set forth is largely due to the fact that we have thoughtlessly conceived the value of geography to be individual and mercenary rather than mutual and altruistic; and that we have never realized that the purposes of geography might include definite provision for proper social orientation in the world of increasingly interdependent workers as well as for physical orientation in the world of objects.

In the new world order that is upon us, geography occupies a unique place. It is the chief subject upon which we may depend for the moral teaching of these complex human relationships. It occupies a field that is peculiarly its own. One may search through the other subjects of the common school, in vain, to find any systematic attempt to present a comprehensive view of the home, the life and work of the Brazilian or any other modern peoples. The program of the new era calls for the elimination of international strife and jealousies, and the substitution of friendship and the cooperative spirit. The place to begin the rehearsal of this program is in the geography class of the elementary school.

Organization to avert international conflict in the future must provide for a better understanding between races and peoples. Geography deals with the activities of modern peoples as they are busying themselves in the noble task of providing the world with the necessities of life. The better we understand our relationships in connection with these activities, the better we will be able to adjust our conflicting interests without appeal to arms. Intelligence alone will never make the world safe for democracy. It is only when intelligence is tempered with virtue that the world will be safe indeed.

The program for the new geography is a complete one. It provides for a study of man not only in relation to the economic and industrial phases of his physical environment but rounds out and completes the program by introducing the most vital and necessary element in the whole field of geography, namely, the social and moral obligations that perforce go with such closely interwoven human interests. To be sure, some of these problems are too complex and difficult for elementary pupils, but there are simple and easily understood phases of the social and moral elements of geography that we dare not omit, even in the elementary school. Let it be said that this generation not only had the physical and moral courage to crush the head of autocratic government in the world, but that, along with the many other worthy provisions looking to the future security of the world, it was wise enough and good enough to organize a complete program for geographical training, one calculated to take full advantage of geographical knowledge in introducing the moral and social corollaries that should accompany geographical principles.

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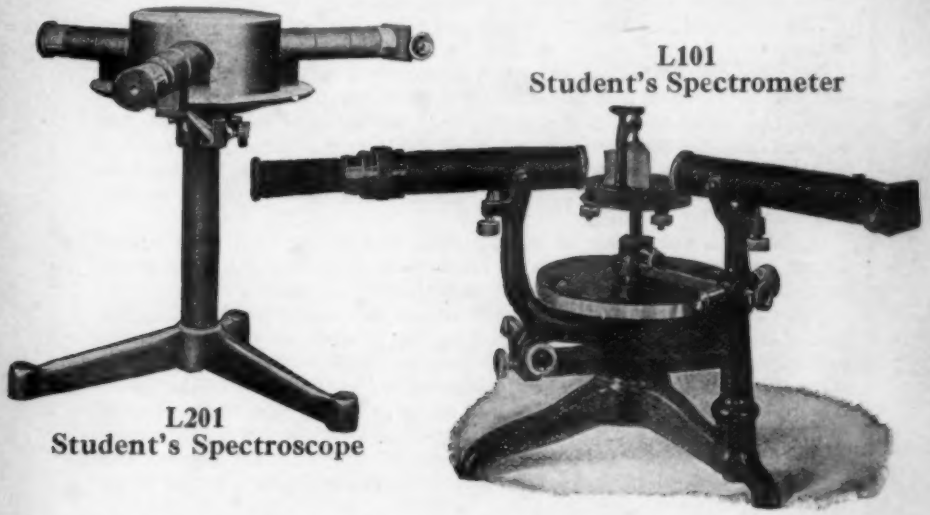

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term of September. After conferring with representatives of all the motion picture companies interested in educational subjects, Dr. Ernest Crandall, Director of Visual Instruction of the Board of Education, has selected T. K. Peters of this city to furnish the city schools with regular courses in biology, geography, English, and other subjects. These courses have been prepared by Mr. Peters as the result of nine years study and work along educational film lines and are so arranged as to supplement existing standard textbooks as used in every state in the Union. The biology course will consist of 22,000 feet of film and will be shown one subject every day during the entire school term. The geography course consists of about 50,000 feet of film. Ten schools have been selected as a start, but the number will be increased from time to time. Other courses have been prepared and will be released as fast as facilities are available for their distribution.

GEOLOGY AND WAR.

Modern scientific warfare compels an army to seek every possible advantage by making full use of all sources of information about the physical conditions within the theater of operations. Of two opposing armies the one having the better knowledge of the terrain will have the advantage—at times a decisive advantage. A complete knowledge of the terrain is, however, possible only by the use of geology.

The principal applications of geology to military problems are as follows:

(1) The determination of water resources, both underground and surface, at the front and along the line of communication.

(2) The determination of the physical character of soil, subsoil, and bedrock, and the presence or absence of underground water, with relation to their effect on fieldworks, including trenches, dugouts, and mines.

(3) The distribution, occurrence, and quantity of road metal, ballast, and material for concrete.

(4) The determination of the physical character of soil and subsoil during wet and dry seasons, with relation to its influence on the movement of large bodies of troops and of artillery and tanks.

Practically all uses of geology fall within the above general classification. It is evident that any engineering project involving extensive excavation may call for geologic knowledge. It is evident, too, that the sanitation of camps and cantonments must take cognizance of the underground drainage conditions as well as of water supply and surface formations. It has been found that certain geologic conditions, by furnishing good electric transmission, favor the use of the listening devices that were extensively used during the period of trench warfare in the World War.

Though the application of geology to war seems to be almost self-evident, it was not recognized prior to the outbreak of hostilities in Europe. The utility of the science to an army in the field soon became evident, however, and before the end of the war nearly all the great powers had organized geologic staffs. A staff of 18 geologic engineer officers had been authorized for the American Expeditionary Force, of whom 11 had been inducted into the service in France.—[*U. S. Geol. Survey.*

USES OF PEAT.

Devotees of the automobile and motor boat will be glad to know that successful experiments have been made in Sweden in extracting wood alcohol from peat. The process as reported by the commercial attache at Copenhagen, Denmark, is described in a report on peat in 1919 recently issued by the United States Geological Survey, Department of the Interior. Interesting instances of the use of peat as a fuel are given in this report. A coastwise steamship company of Norway, for example, during the coal shortage was enabled by the use of peat fuel to keep up its full sailing schedule.—[*U. S. Geol. Survey.*

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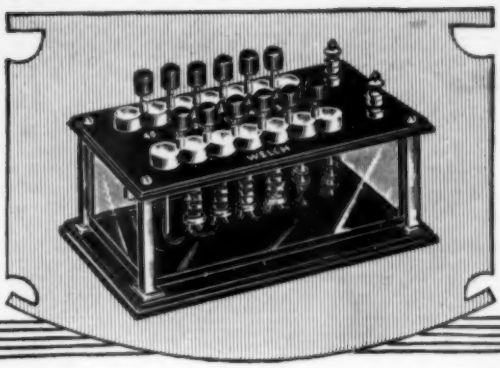

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